



US Army Corps
of Engineers
Baltimore District

CONSTRUCTION SPECIFICATIONS

GATED SPILLWAY ELECTRICAL & CONTROL UPGRADE,

RAYSTOWN LAKE, PA

INVITATION NO. **W912DR-04-B-0018**

CONTRACT NO.

DATE **AUG 02, 2004**

PROJECT TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

01010 GENERAL REQUIREMENTS
01070 CUTTING, PATCHING AND REPAIRING
01200 WARRANTY REQUIREMENT
01330 SUBMITTAL PROCEDURES
01420 SOURCES FOR REFERENCE PUBLICATIONS

DIVISION 05 - METALS

05120 STRUCTURAL STEEL
05500 MISCELLANEOUS METAL

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07600 FLASHING AND SHEET METAL

DIVISION 11 - EQUIPMENT

11287 TAINTER GATE MOTORS

DIVISION 13 - SPECIAL CONSTRUCTION

13801 UTILITY MONITORING AND CONTROL SYSTEM (UMCS)

DIVISION 15 - MECHANICAL

15050 BASIC MECHANICAL MATERIALS AND METHODS
15070 MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL
15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS
15182 REFRIGERANT PIPING
15700 UNITARY HEATING AND COOLING EQUIPMENT
15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

DIVISION 16 - ELECTRICAL

16050 BASIC ELECTRICAL MATERIALS AND METHODS
16410 AUTOMATIC TRANSFER SWITCH AND BY-PASS/ISOLATION SWITCH
16415 ELECTRICAL WORK, INTERIOR
16751 CLOSED CIRCUIT TELEVISION SYSTEMS
16768 FIBER OPTIC DATA TRANSMISSION SYSTEM
16792 WIRE LINE DATA TRANSMISSION SYSTEM

-- End of Project Table of Contents --

SECTION 01010

GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

1.1.1 PROGRESS SCHEDULING AND REPORTING: (AUG 1999)

The Contractor, shall within ten days or as otherwise determined by the Contracting Officer, after date of commencement of work, submit for approval a practicable progress schedule showing the manner in which he intends to prosecute the work. Contractor prepared form shall contain the same information as shown on the attached NADB Form 1153 ("Physical Construction Progress Chart" (CENAB-CO-E)

1.1.2 PAYMENTS TO CONTRACTORS: (NOV 1976)

For payment purposes only, an allowance will be made by the Contracting Officer of 100 percent of the invoiced cost of materials or equipment delivered to the site but not incorporated into the construction, pursuant to the Contract Clause entitled "PAYMENTS UNDER FIXED-PRICE CONSTRUCTION CONTRACTS". The Contracting Officer may also, at his discretion, take into consideration the cost of materials or equipment stored at locations other than the jobsite, when making progress payments under the contract. In order to be eligible for payment, the Contractor must provide satisfactory evidence that he has acquired title to such material or equipment, and that it will be utilized on the work covered by this contract. Further, all items must be properly stored and protected. Earnings will be computed using 100% of invoiced value. (CENAB-CO-E)

1.1.3 PURCHASE ORDER: (SEP 1975 REV JUN 1991)

One readable copy of all purchase orders for material showing firm names and addresses, and all shipping bills, or memoranda of shipment received regarding such material, shall be furnished to the appointed Contracting Officer's Representative as soon as issued. Such orders, shipping bills or memoranda shall be so worded or marked that all material can be definitely identified on the drawings. At the option of the Contractor, the copy of the purchase order may or may not indicate the purchase price. (CENAB-CO-E)

1.1.4 NEGOTIATED MODIFICATIONS: (OCT 84)

Whenever profit is negotiated as an element of price for any modification to this contract with either prime or subcontractor, a reasonable profit shall be negotiated or determined by using the OCE Weighted Guidelines method outlined in EFARS 15.902. (Sugg. NAB 84-232)

1.1.5 PHOTOGRAPHS (SEP 85 REV JUN 1991)

The Contractor shall provide photographic coverage under this contract. Provide a minimum of ten commercial grade color photographs taken at every three months, from the beginning of the contract until final acceptance of the completed work. These photographs shall be of 8" x 10" size and shall be taken at the intervals and locations as directed by the Contracting

Officer. (CENAB-CO) Negatives from all of the above photographs shall be given to and become property of the government.

1.1.6 EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE (EFARS 52.0231.5000 (OCT 1995))

(a) This clause does not apply to terminations. See 52.249-5000, Basis for settlement of proposals and FAR Part 49.

(b) Allowable cost for construction and equipment in sound workable conditions owned or controlled and furnished by a contractor or subcontractor at any tier shall be based on actual costs data for each piece of equipment or groups of similar serial and services for which the government can determine both ownership and operating costs from the contractor's accounting records. When both ownership and operating costs can not be determined for any piece of equipment or groups of similar serial or series equipment from the contractor's accounting records, costs for that equipment shall be based upon the applicable provisions of EP1110-1-8 Construction Equipment Ownership and Operating Expenses Schedule, Region East. Working conditions shall be considered to be average for determining equipment rates using the schedule unless specified otherwise by the contracting officer. For equipment not included in the schedule, rates for comparable pieces of equipment may be used or a rate may be developed using the formula provided in the schedule. For forward pricing, the schedule in effect at the time of negotiations shall apply. For retroactive pricing, the schedule in effect at the time the work was performed shall apply.

(c) Equipment rental costs are allowable, subject to the provisions of FAR 31.105(d) (ii) and Far 31.205-36. Rates for equipment rented from an organization under common control, lease-purchase arrangements, and sale-leaseback arrangements, will be determined using the schedule, except that actual rates will be used for equipment leased from an organization under common control that has an established proactive of leasing the same or similar equipment to unaffiliated leasees.

(d) When actual equipment costs are proposed and the total amount of the pricing action exceeds the small purchase threshold, the contracting officer shall request the contractor to submit either certified cost or pricing data, or partial/limited data, as appropriate. The data shall be submitted on Standard Form 1411, Contract Pricing Proposal Cover Sheet. CENAB-CT/SEP 95 (EFARS 52.231-5000)

1.1.7 REAL PROPERTY EQUIPMENT DATA: (APR 1975)

At or before the time of completion of the contract, the Contractor shall submit to the Contracting Officer a complete itemized list, including serial and model number where applicable, showing the unit retail value of each Contractor furnished item of controls, mechanical and electrical equipment installed by the Contractor under this contract. For each of the items which is specified herein to be guaranteed for a specified period from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier, against defective materials, design, and workmanship, the following information shall be given: the name, address and telephone number of the Subcontractor, Equipment Supplier, or Manufacturer originating the guaranteed item. The list shall be accompanied by a copy of the specific guarantee document for each item which is specified herein to be guaranteed if one had been furnished to the Contractor by the Equipment Supplier or Manufacturer. The Contractor's

guarantee to the Government of these items will not be limited by the terms of any manufacturer's guarantee to the Contractor. Baltimore District NADB Form 1019 may be utilized for the itemized listing and will be made available to the Contractor upon request. (CENAB-CO-E)

1.1.8 O and M DATA: (JUL 1979)

The requirements for furnishing operating and maintenance data and field instruction are specified elsewhere in the specifications. The Contractor shall submit to the Contracting Officer, at a time prior to the 50% project completion time, a list of proposed maintenance and instruction manuals to be furnished the Government and the scheduled dates of all required field instructions to be provided by Contractor furnished personnel or manufacturer's representatives. All maintenance and instruction manuals must be furnished to the Contracting Officer at least 2 weeks prior to the scheduled dates of any required Contractor furnished field instructions or at least one month prior to project completion if no Contractor furnished field instructions are required. (CENAB)

1.1.9 PERFORMANCE AND PAYMENT BOND REIMBURSEMENT: (MAY 1983)

The Government will reimburse the Contractor for the entire amount of premiums paid for Performance and Payment Bonds (including coinsurance and reinsurance agreements when applicable) at the contract lump sum amount under the Unit Price Schedule Item No. 01000-1, entitled "Reimbursement of Performance and Payment Bonds." Such payment will be made only after the Contractor furnishes to the Government evidence of full payment to the surety. In no case will any payment be made by the Government for reimbursement of Performance and Payment Bonds exceeding that amount bid by the Contractor under the aforementioned Unit Price Schedule Item. (CENAB)

1.1.10 MEASUREMENT AND PAYMENT

Except as noted in paragraph, PERFORMANCE AND PAYMENT BOND REIMBURSEMENT above, no separate measurement and payment will be made for the work performed in this Section and all costs in connection therewith shall be considered a subsidiary obligation of the Contractor, and shall be included in the overall cost of the work.

1.2 JOB CONDITIONS

1.2.1 LAYOUT OF WORK: (APR 1972)

The Contractor shall lay out his work and shall be responsible for all measurements in connection therewith. The Contractor shall furnish, at his own expense, all templates, platforms, equipment, tools and materials and labor as may be required in laying out any part of the work. The Contractor will be held responsible for the execution of the work to such lines and elevations shown on the drawings or indicated by the Contracting Officer. (CENAB)

1.2.2 TRANSPORTATION FACILITIES:

RAYSTOWN LAKE, PA.

Transportation Facilities: Raystown Lake is located in Huntingdon County in South-Central Pennsylvania, about 30 miles from the towns of State College and Altoona, PA. Site is accessed by motor vehicle only.

1.2.3 AVAILABILITY OF UTILITIES INCLUDING LAVATORY FACILITIES: (JUN 1980)

It shall be the responsibility of the Contractor to provide all utilities including portable emergency generator and related items, he may need during the entire length of the contract. He shall make his own investigation and determinations as to the availability and adequacy of the present utilities for his use for construction purposes and domestic consumption. He shall install and maintain all necessary supply lines, connections, piping, and meters if required, but only at such locations and in such manner as approved by the Contracting Officer. Before final acceptance of work under this contract, all temporary supply lines, connections and piping installed by the Contractor shall be removed by him in a manner satisfactory to the Contracting Officer. (CENAB)

1.2.4 Utility Markings (Aug 1999)

The Contractor shall contact the facility manager as well as COE at Baltimore District and the One-Call Service Station, a minimum of 14 days and 48 hours, respectively, prior to any excavation, requesting exact utility location markings. The Contractor shall not proceed with any excavation until all utilities, including abandoned utilities, have been marked to the satisfaction of the Contracting Officer. Prior to requesting the marking of utilities, the Contractor shall stake out proposed excavations and limits of work with white lines ("White Lining"). It is the Contractor's responsibility to ensure that all required permits (excavation or otherwise, including Government permits) are current and up-to-date without expiration. In addition to the above requirements the Contractor shall:

- a) Visually survey and verify that all utility markings are consistent with existing appurtenances such as manholes, handholes, pad-mounted devices, etc. prior to any excavation.
- b) Hand dig test holes to verify the depth and location of all utilities prior to any mechanical excavation within the limits of work. Other non-damaging methods for utility verification, as indicated in (d) below, may be considered subject to approval by the Contracting Officer. Also, verify that any abandoned utilities are not active.
- c) Preserve all utility markings for the duration of the project to the furthest extent possible.
- d) When excavation is performed within 2 feet of any utility line, a non-damaging method of excavation shall be used. The non-damaging method shall be hand digging. Other non-damaging methods, such as, soft digging, vacuum excavation, pneumatic hand tools, may be considered subject to approval by the Contracting Officer.
- e) Regardless of the type of excavation, the Contractor shall notify the Contracting Officer a minimum of 72 hours prior to any excavation activity. Failure to notify the Contracting Officer can result in the issuance of a "Stop Work" order, which shall not be justification for contract delay or time extension. The Government reserves the right to have personnel present on site during any type of excavation.
- f) The Contractor shall ensure that all excavation requirements herein are met at the time of the preparatory phase of quality

control, and that the excavation procedures are reviewed during the preparatory phase meeting. This preparatory phase of control shall also establish and document contingency plans and actions to be followed in the event that existing utilities are damaged or interrupted. Locations of shut off or isolation devices along with other safety features shall be established and their operation reviewed.

- g) Any work other than excavation in the vicinity of a utility, that could damage or interrupt a utility, such as, exterior or interior work near transformers, power lines, telephone lines, etc., shall be done with extreme care. The Contractor shall specifically note during the preparatory phase of quality control, the construction techniques to be used to preclude damaging or interrupting any utility. This preparatory phase of control shall also establish and document contingency plans and actions to be followed in the event that existing utilities are damaged or interrupted. Locations of shut off or isolation devices along with other safety features shall be established and their operation reviewed.

1.2.5 COMPLIANCE WITH RAYSTOWN LAKE REGULATIONS: (JUL 1980)

The site of the work is at Raystown Lake in Pennsylvania and all rules and regulations issued by the local governing/inspection authorities as well as by Mr. Dwight R. Beall, Operations Manager covering general safety, security, sanitary requirements, pollution control, traffic regulations and parking, shall be observed by the Contractor. Information regarding these requirements may be obtained by contacting the local authorities and Contracting Officer, who will provide such information or assist in obtaining same from appropriate authorities. (MEMO)

1.2.6 IDENTIFICATION OF EMPLOYEES: (OCT 1983)

Each employee assigned to this project by the Contractor and subcontractors shall be required to display at all times, while on the project site, an approved form of identification provided by the Contractor, as an authorized employee of the Contractor/subcontractor. In addition, on those projects where identification is prescribed and furnished by the Government, it shall be displayed as required and it shall immediately be returned to the Contracting Officer for cancellation upon release of the assigned employee and or completion of project. (CENAB)

1.2.7 MAINTENANCE OF ACCESS: (DEC 1975)

The Contractor shall not block passage through sidewalks, access roads, or entranceways to the building(s) during performance of work under this contract. No construction materials are to be stored in the building(s) at any time unless authorized by the Contracting Officer. (CENAB)

1.2.8 PROTECTION OF GOVERNMENT PROPERTY AND PERSONNEL: (DEC 1975 REV JUN 1991)

1.2.8.1 Equipment Protection

All existing equipment located within the work area shall be protected by the Contractor from damage caused by renovation operations. As a minimum, the Contractor shall cover and protect all equipment, motors, cabinets, etc. to remain with dust barriers or other protective covers prior to commencement of construction in the area.

1.2.8.2 Damaged Facilities

All existing facilities damaged as a result of the construction activities shall be restored to a condition better or at least equivalent to that prior to the start of work at no additional cost to the government. Materials for replacement, repairing, patching, restoration, and similar type work shall match existing adjoining surfaces.

1.2.8.3 Personnel Protection

The Contractor shall protect personnel by installing safety rails and/or barricades as applicable to prevent injury from unauthorized entry into work areas. Warning signs shall be erected as necessary to indicate construction areas and hazardous zones. Work shall proceed in such manner as to prevent the undue spread of dust and flying particles.

1.2.8.4 Additional Measures

The Contractor shall take such additional measures as may be directed by the Contracting Officer to prevent damage or injury to Government property or personnel. (CENAB)

1.2.9 ASBESTOS

1.2.9.1 ASBESTOS HANDLING AND REMOVAL: (FEB 85)

Through site investigations, friable asbestos has not been found. However, if asbestos is encountered, immediately notify the Contracting Officer without proceeding with the work in the area/vicinity. Further testing, removal and disposal will be addressed under "CHANGES" clause of the Contract Clauses. (CENAB)

1.2.10 TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER:

1.2.10.1 Procedure for Time Extensions

This provision specifies the procedure for determination of time extensions for unusually severe weather in accordance the contract clause entitled "Default: (Fixed Price Construction)". In order for the Contracting Officer to award a time extension under this clause, the following conditions must be satisfied:

- a. The weather experienced at the project site during the contract period must be found to be unusually severe, that is, more severe than the adverse weather anticipated for the project location during any given month.
- b. The unusually severe weather must actually cause a delay to the completion of the project. The delay must be beyond the control and without the fault or negligence of the Contractor.

1.2.10.2 Monthly Schedule

The following schedule of monthly anticipated adverse weather delays is based on National Oceanic and Atmospheric Administration (NOAA) or similar data for the project location and will constitute the base line for monthly weather time evaluations. The contractor's progress schedule must reflect these anticipated adverse weather delays

in all weather dependent activities.

MONTHLY ANTICIPATED ADVERSE WEATHER DELAY
WORK DAYS BASED ON (5) DAY WORK WEEK

RAYSTOWN LAKE, PA.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
19	11	9	9	9	9	6	7	5	6	6	13

1.2.10.3 Notice to Proceed (NTP)

Upon acknowledgment of the Notice to Proceed (NTP) and continuing throughout the contract, the Contractor will record on the daily CQC report, the occurrence of adverse weather and resultant impact to normally scheduled work. Actual adverse weather delay days must prevent work on critical activities for 50 percent or more of the contractor's scheduled work day. The number of actual adverse weather delay days shall include days impacted by actual adverse weather (even if adverse weather occurred in previous month), be calculated chronologically from the first to the last day of each month, and be recorded as full days. If the number of actual adverse weather delay days exceeds the number of days anticipated in paragraph "Monthly Schedule", above, the Contracting Officer will convert any qualifying delays to calendar days, giving full consideration for equivalent fair weather work days, and issue a modification in accordance with the contract clause entitled "Default (Fixed Price Construction)".

1.2.11 WORKING HOURS: (DEC 93)

The normal working hours at the project site are 5 weekdays, Monday through Friday, 8:00 a.m. to 4:30 p.m. The contractor must request in writing any work periods outside of this time frame. Approval is not guaranteed and will be based on availability of Government (Facility's) personnel and necessity of such working hours.

1.3 SAFETY

1.3.1 GENERAL

Worker safety is of paramount importance. The Contractor shall comply with the Contract Clause in the Solicitation entitled ACCIDENT PREVENTION, including the U.S. Army Corps of Engineers Safety and Health Requirements Manual referred to therein in addition to the provisions of this specification.

1.3.1.1 ACCIDENTS

Chargeable accidents are to be investigated by both Contractor personnel and the Contracting Officer.

1.3.1.2 ACCIDENT REPORTING, ENG FORM 3394

Section 1, Paragraph 01.D, of EM 385-1-1 (3 Sep 1996) "U.S. Army Corps of Engineers Safety and Health Requirements Manual" and the Contract Clause entitled ACCIDENT PREVENTION are amended as follows: The prime Contractor shall report on Eng Form 3394, supplied by the Contracting Officer, all injuries to his employees or subcontractors that result in lost time and all damage to property and/or equipment in excess of \$2,000 per incident. Verbal notification of such accident shall be made to the Contracting

Officer within 24 hours. A written report on the above noted form shall be submitted to the Contracting Officer within 72 hours following such accidents. The written report shall include the following:

a. A description of the circumstances leading up to the accident, the cause of the accident, and corrective measures taken to prevent recurrence.

b. A description of the injury and name and location of the medical facility giving examination and treatment.

c. A statement as to whether or not the employee was permitted to return to work after examination and treatment by the doctor, and if not, an estimate or statement of the number of days lost from work. If there have been days lost from work, state whether or not the employee has been re-examined and declared fit to resume work as of the date of the report.

1.3.1.3 OSHA Requirements

1.3.1.4 OSHA Log

A copy of the Contractor's OSHA Log of Injuries shall be forwarded monthly to the Contracting Officer.

1.3.1.5 OSHA Inspections:

Contractors shall immediately notify the Contracting Officer when an OSHA Compliance official (Federal or State representative) presents his/her credentials and informs the Contractor that the workplace will be inspected for OSHA compliance. Contractors shall also notify the Contracting Officer upon determination that an exit interview will take place upon completion of the OSHA inspection. (NABSA OCT 05, 1976)

1.4 SECURITY

The Contractor shall submit a photo copy of each member of the contractor's staff identification to the Operations Manager at least fifteen days prior to arrival at the site. Each staff member will be required to have their photo identification with them at all times while on the project site.

All of the contractor's employees, subcontract employees or vendor deliveries who will be on Government property during the performance of this work must be a citizen of the United States of America, or an alien who has been lawfully admitted for permanent residence as evidenced by an Alien Registration Receipt Card, Form I-151, or who presents other evidence from the INS that employment will not affect his/her immigration status. Contractors will, at government request, provide names and a pertinent identifying number (driver's license, SSN) etc. of all employees expected to work on the job site. This information shall be made available NLT one week after the government's request. The government reserves the right to prohibit the entrance of any employee to the site based on unfavorable background checks.

252.204-7000, Disclosure of Information (Dec 1991).

252.204-7003, Control of Government Personnel Work Product (Apr 1992).

Bidders are responsible for determining, in advance of bidding, the federal installation security requirements including, but not limited to, access, escort, identification, search procedures, and vehicle registration

requirements that may impact contract work performance. At no additional cost to the government, Contractors shall be responsible for complying with all security requirements at each installation.

Photos may not be taken while on the work site except as stipulated by contract terms and only when authorized by the Contracting Officer.

1.5 CONTRACTOR QUALITY CONTROL

1.5.1 GENERAL

The Contractor shall provide and maintain an effective quality control program that complies with the Contract Clause entitled "Inspection of Construction." The CQC Program through inspection and reporting shall demonstrate and document the extent of compliance of all work with the standards and quality established by the contract document. The burden of proof of contract compliance is placed on the Contractor and not assumed by the Government. The Contractor's Quality Control will not be accepted without question.

1.5.2 CONTROL

Contractor Quality Control (CQC) is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. The controls shall be adequate to cover all construction operations, including both on-site and off-site fabrication, and will be keyed to the proposed construction sequence.

1.5.2.1 Physical Examination

A physical examination of required materials, equipment, and sample work to assure that they are on hand for the stage of work about to begin.

1.5.2.2 Physical Inspections

Daily checks shall be performed to assure continuing compliance with contract requirements, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation.

1.5.3 WORK DEFICIENCIES

The Contractor shall not build upon or conceal non-conforming work. If deficiencies indicate that the Contractor's Quality Control is not adequate or does not produce the desired results, corrective actions shall be taken by the Contractor. If the Contractor does not promptly make the necessary corrections, the Contracting Officer may issue an order stopping all or any part of the work until satisfactory corrective action has been taken. Payment for deficient work will be withheld until work has been satisfactorily corrected or other action is taken pursuant to the Contract Clause entitled, "Inspection of Construction." If recurring deficiencies in an item or items indicated that the quality control is not adequate, such corrective actions shall be taken as directed by the Contracting Officer.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When

used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Title Evidence.

Proof of purchase for equipment and/or materials.

Invoice Copies.

Proof of rental equipment costs.

Payment Evidence.

Proof of full payment.

Checklist; G AR

A Risk Assessment for excavation and other work in the vicinity of utilities.

OSHA Log.

A log shall be reported monthly for injuries.

CQC Program; G AR.

A program that complies with the Contract Clause entitled "Inspection of Construction."

Photographs.

Commercial grade color photographs.

SD-05 Design Data

Change Notification.

Any changes made by the Contractor.

Progress Schedule; G AR.

A schedule that shows the manner in which the Contractor intends to prosecute the work.

Modified Chart; G AR.

Prepared when changes are authorized that result in contract time extensions.

1.6.1 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.6.1.1 Government Approved

Governmental approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system

must be checked, and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specification and Drawings for Construction," they are considered to be "shop drawings."

1.6.1.2 Information Only

All submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referenced above.

1.6.2 APPROVED SUBMITTALS

The approval of submittals by the Contracting Officer shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailed and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the CQC requirements of this contract, is responsible for the dimensions and design of adequate connections, details and satisfactory construction of all work. After submittals have been approved by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be given consideration unless accompanied by an explanation as to why a substitution is necessary.

1.6.3 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Contracting Officer and promptly furnish a corrected submittal in the form and number of copies as specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, notice as required under Contract Clause entitled "Changes" shall be given promptly to the Contracting Officer.

1.6.4 GENERAL

The Contractor shall submit all items listed on the Submittal Register (ENG Form 4288) or specified in the other sections of these specifications. The Contracting Officer may request submittals in addition to those listed when deemed necessary to adequately describe the work covered in the respective sections. Submittals shall be made in the respective number of copies and submitted to the Contracting Officer. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor and each respective transmittal form (ENG Form 4025) shall be stamped, signed and dated by the Contractor certifying that the accompanying submittal complies with the contract requirements. Proposed deviations from the contract requirements shall be clearly identified. Submittals requiring Government approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby.

1.6.5 SUBMITTAL REGISTER: (ENG FORM 4288)

At the end of this section is one set of ENG Form 4288 listing items of equipment and materials for which submittals are required by the specifications; this list may not be all inclusive and additional submittals may be required. The Contractor will also be given the submittal register files, containing the computerized ENG Form 4288 and instructions on the use of the files. These submittal register files will

be furnished on the Award CD-ROM disk. Columns "c" through "f" have been completed by the Government; the Contractor shall complete columns "a" and "g" through "i" and submit the forms (hard copy plus associated electronic file) to the Contracting Officer for approval within 30 calendar days after Notice to Proceed. The Contractor shall keep this diskette up-to-date and shall submit it to the Government together with the monthly payment request. The approved submittal register will become the scheduling document and will be used to control submittals throughout the life of the contract. The submittal register and the progress schedules shall be coordinated.

The Contractor shall maintain a submittal register for the project in accordance with Section 01312A QUALITY CONTROL SYSTEMS (QCS).

1.6.6 SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time (a minimum of 30 calendar days exclusive of mailing time) shall be allowed on the register for review and approval. No delays, damages or time extensions will be allowed for time lost in late submittals.

1.6.7 TRANSMITTAL FORM (ENG FORM 4025)

The sample transmittal form (ENG Form 4025) attached to this section shall be used for submitting both Government approved and information only submittals in accordance with the instructions on the reverse of the form. These forms will be furnished to the Contractor. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care will be exercised to ensure proper listing of the specification paragraph and/or sheet number of the contract drawings pertinent to the data submitted for each item.

1.6.8 SUBMITTAL PROCEDURE

Six (6) copies of submittals shall be made as follows:

1.6.8.1 Procedures

This paragraph is in addition to the requirements set forth in Contract Clause entitled "Specifications and Drawings for Construction" (ER 415-1-10). In the signature block provided on ENG Form 4025 the Contractor certifies that each item has been reviewed in detail and is correct and is in strict conformance with the contract drawings and specifications unless noted otherwise. The accuracy and completeness of submittals is the responsibility of the Contractor. Any costs due to resubmittal of documents caused by inaccuracy, lack of coordination, and/or checking shall be the responsibility of the Contractor. This shall include the handling and review time on the part of the Government. Each variation from the contract specifications and drawings shall be noted on the form; and, attached to the form, the Contractor shall set forth, in writing, the reason for and description of such variations. If these requirements are not met, the submittal may be returned for corrective action.

1.6.8.2 Deviations

For submittals which include proposed deviations requested by the

Contractor, the column "variations" of ENG Form 4025 shall be checked. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal. The government reserves the right to rescind inadvertent approval of submittals containing unnoted deviations.

1.6.9 GOVERNMENT APPROVED SUBMITTALS

Upon completion of review of submittals requiring Government approval, the submittals will be identified as having received approval by being stamped and dated. Four (4) copies of the submittal will be retained by the Contracting Officer and two (2) copies of the submittal will be returned to the Contractor.

1.6.10 INFORMATION ONLY SUBMITTALS

Normally submittals for information only will be returned. Approval of the Contracting Officer is not required on information only submittals. These submittals will be used for information purposes. The government reserves the right to require the Contractor to resubmit any item found not to comply with the contract.

1.6.11 STAMPS

Stamps used by the Contractor on the submittal data to certify that the submittal meets contract requirements shall be similar to the following:

(Firm Name)

_____ Approved

_____ Approved with corrections as noted on submittal data
and/or attached sheet(s).

SIGNATURE: _____

TITLE: _____

DATE: _____

1.7 ENVIRONMENTAL PROTECTION

1.7.1 APPLICABLE REGULATIONS

The Contractor and his subcontractors in the performance of this contract, shall comply with all applicable Federal, State, and local laws and regulations concerning environmental pollution control and abatement in effect on the date of this solicitation, as well as the specific requirements stated elsewhere in the contract specifications.

1.7.2 NOTIFICATION

The Contracting Officer will notify the Contractor of any non-compliance with the foregoing provisions and the action to be taken. The Contractor shall, after receipt of such notice, immediately take corrective action. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of time lost due to

any such stop order shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it is later determined that the Contractor was in compliance.

1.7.3 PROTECTION OF WATER RESOURCES

The Contractor shall not pollute streams, lakes or reservoirs with fuels, oils, bitumens, calcium chloride, acid construction wastes or other harmful materials. All work under this contract shall be performed in such a manner that objectionable conditions will not be created in streams through or adjacent to the project areas.

1.7.4 BURNING

Burning will not be allowed.

1.7.5 DUST CONTROL

The Contractor shall maintain all work area free from dust which would contribute to air pollution. Approved temporary methods of stabilization consisting of sprinkling, chemical treatment, light bituminous treatment or similar methods will be permitted to control dust. Sprinkling, where used, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs.

1.8 AS-BUILT DRAWINGS - CADD

1.8.1 PROGRESS MARKED UP AS-BUILT PRINTS

The Contractor shall mark up one set of paper prints to show the as-built conditions. These as-built marked prints shall be kept current and available on the jobsite at all times. All changes from the contract plans which are made in the work or additional information which might be uncovered in the course of construction shall be accurately and neatly recorded as they occur by means of details and notes. The as-built marked prints will be jointly inspected for accuracy and completeness by the Contracting Officer's representative and a responsible representative of the Construction Contractor prior to submission of each monthly pay estimate. The drawings shall show the following information, but not be limited thereto:

1.8.1.1 Final Revisions

When final revisions have been completed, each drawing shall be lettered or stamped with the words "RECORD DRAWING AS-BUILT" followed by the name of the General Contractor in letters at least 3/16" high.

1.8.2 DRAWING PREPARATION

Upon approval of the as-built prints submitted, the Contractor will be furnished the original set of contract drawings with all amendments incorporated. These drawings shall be modified as may be necessary to correctly show all the features of the project as it has been constructed by bringing the contract set into agreement with the approved as-built prints, adding such additional drawings as may be necessary. These drawings are part of the permanent records of this project and the Contractor shall be responsible for the protection and safety thereof until returned to the Contracting Officer. Any drawings damaged or lost by the

Contractor shall be satisfactorily replaced by the Contractor at his expense.

PART 2 PRODUCT -- NOT APPLICABLE

PART 3 EXECUTION -- NOT APPLICABLE

ATTACHMENTS

Form 1153
Checklist

Signature-Blks

-- End of Section --

**RISK ASSESSMENT FOR
EXCAVATION AND OTHER WORK IN THE VICINITY OF UTILITIES**

PROJECT NAME: _____
CONTRACT NUMBER: _____
PROJECT INSTALLATION AND LOCATION: _____
PROPOSED EXCAVATION START DATE: _____

1. ☐ **ESTABLISH** EXCAVATION DETAILS AND DRAWINGS (check when completed)
2. ☐ PROPOSED EXCAVATION AREA MARKED ("white lining") (check when completed)
3. ☐ CONTACT APPROPRIATE ONE-CALL SERVICE **FOR PUBLIC UTILITIES:**
MD: Miss Utility 1-800-257-7777 N Y : New York City - Long Island One Call Center 1-800-272-4480
N. VA: Miss Utility 1-800-552-7777 PA: Pennsylvania One-Call System Incorporated 1-800-242-1776
VA: Miss Utility of VA 1-800-552-7001 DC: Miss Utility 1-800-257-7777
ONE-CALL NATIONAL REFERRAL CENTER: 1-888-258-0808

☐ **CONTACT INSTALLATION/OWNERS OF ALL PRIVATELY OWNED UTILITIES (NON ONE-CALL MEMBERS)**

4. ☐ DATE UTILITIES MARKED AND METHOD OF MARKING
ONE-CALL LOCATORS _____
OTHER LOCATORS _____
5. ☐ CONTACT APPROPRIATE DPW REPRESENTATIVES AND COMPLY WITH INSTALLATION PERMIT REQUIREMENTS: _____
6. ☐ UTILITIES IDENTIFIED ON-SITE:
☐ NONE ☐ ELECTRIC ☐ GAS ☐ WATER ☐ TELEPHONE ☐ CATV ☐ SEWER ☐ OTHER _____
7. ☐ LEVEL OF RISK: (Based upon personnel safety and consequences of utility outages.)
☐ SEVERE: Excavation required within the immediate vicinity (<2-ft) of a MARKED utility.
☐ MODERATE: Excav. required outside the immediate vicinity (> 2-ft) of MARKED utility.
☐ MINIMAL: Excavation required in an area with NO utilities.
8. ☐ EXISTING FACILITIES/UTILITIES IN VICINITY:
☐ NON-CRITICAL ☐ MISSION CRITICAL ☐ HIGH-PROFILE ☐ CEREMONIAL
☐ OTHER _____
☐ **CONSEQUENCES IF EXISTING UTILITIES ARE DAMAGED/DISRUPTED** _____
-
9. ☐ ENGINEERING CONTROLS REQUIRED:
☐ NONE ☐ HAND EXCAVATE TO LOCATE UTILITY ☐ EXCAVATE WITH DUE CARE
☐ OTHER _____
10. ☐ ADMINISTRATIVE CONTROLS REQUIRED:
☐ Notification of Contracting Officer's Representative, NOTIFIED on: _____
☐ Notification of Installation/DPW Representative, NOTIFIED on: _____
11. ☐ EMERGENCY NOTIFICATION AT INSTALLATION: POC & PHONE NUMBER _____

THE INFORMATION NOTED ABOVE IS ACCURATE AND THE WORK IS READY TO PROCEED
SIGNED and DATE _____ **CQC MANAGER**

12. ☐ ON-SITE GOVERNMENT REP. RECOMMENDATION FOR APPROVAL TO EXCAVATE:
☐ YES ☐ NO SIGNATURE AND DATE: _____
Comments: _____
13. ☐ AREA ENGINEER APPROVAL TO EXCAVATE:
☐ APPROVED ☐ DENIED SIGNATURE AND DATE: _____
Comments: _____
14. ☐ **CHIEF**, _____ **DIVISION** APPROVAL TO EXCAVATE:
☐ APPROVED ☐ DENIED SIGNATURE AND DATE: _____
Comments: _____

SECTION 01070

CUTTING, PATCHING AND REPAIRING

PART 1 GENERAL

1.1 Description

This section pertains to the provision of all cutting, removing, replacing, patching, repairing, restoration, refinishing and similar type work as necessary to existing work scheduled to remain and to new work required to be cut or uncovered. All existing facilities and/or surfaces damaged as a result of the construction activities shall be restored to a condition equivalent to that prior to the start of work, except where otherwise shown or specified.

1.2 Work Execution

Extent of work includes uncovering work to provide for installation of ill-timed work, removal and replacement of defective work or work that does not conform to the contract documents, installation of new work to be installed in existing construction, and as necessary to make several parts fit.

PART 2 PRODUCTS

2.1 MATERIALS

Materials for replacement, repairing, patching, restoration, and similar type work shall conform to applicable sections of the specifications for new materials or work. Where existing materials and/or installations are not covered by the specifications, such materials shall match existing. All excess materials resulting from cutting and removal work shall be removed from the job site.

PART 3 EXECUTION

3.1 INSPECTION AND PREPARATION

3.1.1 Inspection of Conditions of Work

Inspect all existing conditions of work, for possible movement or damage during cutting or uncovering procedures. After uncovering work, inspect conditions affecting installation of new products. Do not proceed with any further cutting, patching or repairing work if defects are observed; or if any unsafe condition exists.

3.1.2 Preparation of the Work Site

Prior to cutting or uncovering work, provide all shoring, bracing and supports as required to maintain the structural integrity of the project. Prior to restoration work, properly prepare existing surfaces to receive new materials such as to provide a proper bond or joining.

3.2 CUTTING AND DRILLING

Contractor shall do all cutting and drilling of existing walls, partitions, ceilings, floors, etc., as necessary for installation of the new work as shown, including cutting of holes and other openings for new mechanical and electrical work. Cutting shall be performed by hand or small power tools; holes and slots cut neat and to size required, with minimum disturbance of adjacent work; cut holes in concrete slabs for pipes and conduit with core drills of proper sizes. Openings shall be covered temporarily when not in use and patched as soon as work is installed.

3.3 PATCHING AND REPAIRS

3.3.1 Performance of Work

Existing work shall be cut, altered, removed, temporarily removed and replaced, or relocated as required for the performance of the work required. Work remaining in place that is damaged or defaced by reason of alteration or demolition shall be restored to a condition equivalent to that prior to the start of work. Contractor shall be responsible for coordinating all patching and repairing involving the various trades, whether or not specifically mentioned under the respective sections.

3.3.2 Alterations

Where alterations or removals exposes damaged or unfinished surfaces or materials, such surfaces or materials shall be refinished or replaced as necessary to make continuous areas uniform. Where new work by any trade occurs in an existing finished area the entire wall or ceiling surface in which such work occurs shall be refinished. Where such new work occurs in an existing unfinished area, the work shall be done to render the new work inconspicuous.

3.3.3 Utility Removal

Where utilities are removed, relocated, or abandoned, they shall be capped, and working installation as required. Resulting holes and damaged surfaces shall be properly patched to match adjacent undisturbed surfaces or prepared to receive new finish as applicable.

3.3.4 Restoration of Existing Surfaces

All surfaces affected by patching and repairing work shall be restored to match existing adjacent surfaces. Repainting of affected areas or surfaces shall match color and shade of existing painted surfaces.

3.4 MEASUREMENT AND PAYMENT

No separate measurement and payment will be made for the work performed in this Section 01070, CUTTING, PATCHING & REPAIRING specified herein, and all costs in connection therewith shall be considered a subsidiary obligation of the Contractor, and shall be included in the overall cost of the work.

-- End of Section --

SECTION 01200

WARRANTY REQUIREMENT

PART 1 GENERAL

1.1 WARRANTY OF CONSTRUCTION

The Contractor shall warranty all materials and workmanship in accordance with Contract Clause (FAR 52.246-21), "WARRANTY OF CONSTRUCTION"

1.2 MANUFACTURER'S WARRANTY:

The Contractor shall provide manufacturer's warranties, when available, on all equipment except for control equipment for one year starting from the day of facility acceptance by the Government. The controls and control related equipment shall be warranted for a period of five years from final acceptance. Any warranty offered by the manufacturer for periods greater than one year or required by other sections of the specifications shall also be provided.

1.3 WARRANTY PAYMENT

Warranty work is a subsidiary portion of the contract work, and has a value to the Government of \$10,000. The Contractor will assign a value of that amount in the breakdown for progress payments mentioned in the Contract Clause (FAR 52.232-5) "Payments Under Fixed-Price Construction". If the Contractor fails to respond to warranty items as provided in paragraph CONTRACTOR'S RESPONSE TO WARRANTY SERVICE REQUIREMENTS below, the Government may elect to acquire warranty repairs through other sources and, if so, shall backcharge the Contractor for the cost of such repairs. Such backcharges shall be accomplished under the Contract Clause (FAR 52.243-4) "CHANGES" of the contract through a credit modification(s).

1.4 PERFORMANCE BOND:

The Contractor's Performance Bond will remain effective throughout the construction warranty period and warranty extensions.

1.4.1 Failure to Commence

In the event the Contractor or his designated representative(s) fail to commence and diligently pursue any work required under this clause, and in a manner pursuant to the requirements thereof, the Contracting Officer shall have the right to demand that said work be performed under the Performance Bond by making written notice on the surety. If the surety fails or refuses to perform the obligation it assumed under the Performance Bond, the Contracting Officer shall have the work performed by others, and after completion of the work, may demand reimbursement of any or all expenses incurred by the Government while performing the work, including, but not limited to administrative expenses.

1.5 PRE-WARRANTY CONFERENCE:

Prior to contract completion and at a time designated by the Contracting Officer, the Contractor shall meet with the Contracting Officer to develop

a mutual understanding with respect to the requirements of this specification. Communication procedures for Contractor notification of warranty defects, priorities with respect to the type of defect, reasonable time required for Contractor response, and other details deemed necessary by the Contracting Officer for the execution of the construction warranty shall be reviewed at this meeting. The Contractor shall provide names, addresses, and telephone numbers of all subcontractors, equipment suppliers, or manufacturers with specific designation of their area of responsibilities if they are to be contacted directly on warranty corrections. This point of contact will be located within the local service area of the warranted construction, will be continuously available, and will be responsive to Government inquiry on warranty work action and status. Minutes of the meeting will be prepared by the Government and signed by both, the Contractor and the Contracting Officer. The minutes shall become part of the contract file.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Samples

Sample Tags.

To identify the warranty for all Contractor and Government furnished equipment which the Contractor installs.

1.7 ADDITIONAL REQUIREMENTS

1.7.1 Equipment Warranty Identification Tags:

The Contractor shall provide warranty identification tags on all Contractor and Government furnished equipment which he has installed.

1.7.1.1 Format and Size for Tags

The tags shall be similar in format and size to the exhibits provided by this specification, they shall be suitable for interior and exterior locations, resistant to solvents, abrasion, and to fading caused by sunlight, precipitation. etc. These tags shall have a permanent pressure-sensitive adhesive back, and they shall be installed in a position that is easily (or most easily) noticeable. Contractor furnished equipment that has differing warranties on its components will have each component tagged.

1.7.1.2 Sample Tags

Sample tags shall be filled out representative of how the Contractor will complete all other tags. These tags shall be submitted to the Government.

1.7.1.3 Tags for Warranted Equipment:

The tag for this equipment shall be similar to the following. Exact format and size will be as approved.

EQUIPMENT WARRANTY CONTRACTOR FURNISHED EQUIPMENT	
MFG: _____	MODEL NO.: _____
SERIAL NO.: _____	CONTRACT NO.: _____
CONTRACTORS NAME: _____	
CONTRACTOR WARRANTY EXPIRES: _____	
MFG WARRANTY(IES) EXPIRE: _____	

EQUIPMENT WARRANTY GOVERNMENT FURNISHED EQUIPMENT	
MFG: _____	MODEL NO.: _____
SERIAL NO.: _____	CONTRACT NO.: _____
DATE EQUIPMENT PLACED IN SERVICE: _____	
MFG WARRANTY(IES) EXPIRES: _____	

1.7.1.4 Execution

The Contractor will complete the required information on each tag and install these tags on the equipment by the time of and as a condition of final acceptance of the equipment. All tags shall be mechanically attached to the equipment as directed by the Contracting Officer.

1.7.1.5 Equipment Warranty Tag Replacement.

The contractor shall provide new tags on repaired or replaced equipment during the warranty period. The tag shall be identical to the original tag, except that the Contractor's warranty expiration date shall be updated to show the correct warranty expiration date.

1.8 CONTRACTOR'S RESPONSE TO WARRANTY SERVICE REQUIREMENTS.

1.8.1 Notification to Warranty Service Requirements

Following oral or written notification by authorized representative of the installation designated in writing by the Contracting Officer, the Contractor shall respond to warranty service requirements in accordance with the "Warranty Service Priority List" and the three categories of priorities listed below.

1.8.1.1 Categories of Priorities

- a. First Priority Code 1: Perform on site inspection to evaluate situation, determine course of action, initiate work within 24 hours and work continuously to completion or relief.
- b. Second Priority Code 2: Perform on site inspection to evaluate situation, determine course of action, initiate work within 48 hours and work continuously to completion or relief.
- c. Third Priority Code 3: All other work to be initiated within 5 work days and work continuously to completion or relief.

1.8.1.2 Warranty Service Priority List

Code 1

- a. Gate control system.
- b. Power failure.
- c. Security system including lighting.

1.8.2 Availability of Required Parts

Should parts be required to complete the work and the parts are not immediately available the Contractor shall have a maximum of 12 hours after arrival at the job site to provide authorized representative of the installation with firm written plan for emergency alternatives and temporary repairs for Government participation with the Contractor to provide emergency relief until the required parts are available on site for the Contractor to perform permanent warranty repair. The Contractors plan shall include a firm date and time that the required parts shall be available on site to complete the permanent warranty repair.

PART 2 PRODUCTS - NOT APPLICABLE

PART 3 EXECUTION - NOT APPLICABLE

-- End of Section --

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUBMITTAL IDENTIFICATION (SD)

Submittals required are identified by SD numbers and titles as follows:

SD-01 Preconstruction Submittals

SD-02 Shop Drawings

SD-03 Product Data

SD-05 Design Data

SD-06 Test Reports

SD-07 Certificates

SD-08 Manufacturer's Instructions

SD-10 Operation and Maintenance Data

SD-11 Closeout Submittals

1.2 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.2.1 Government Approved

Government approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings."

1.2.2 Information Only

All submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.3 APPROVED SUBMITTALS

The Contracting Officer's approval of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the Contractor Quality Control (CQC) requirements of this contract is responsible for verifying the actual field conditions, available space, exact dimensions of new equipment, the design of adequate connections and mounting details, and the

satisfactory construction and operation of all work. After submittals have been approved by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.4 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Contracting Officer and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, a notice in accordance with the Contract Clause "Changes" shall be given promptly to the Contracting Officer.

1.5 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

1.6 GENERAL

The Contractor shall make submittals as required by the specifications. The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same as those used in the contract drawings. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor's Quality Control (CQC) System Manager and each item shall be stamped, signed, and dated by the CQC System Manager indicating action taken. Proposed deviations from the contract requirements shall be clearly identified. Submittals shall include items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals. Submittals requiring Government approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby. Samples remaining upon completion of the work shall be picked up and disposed of in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

1.7 SUBMITTAL REGISTER

At the end of this section is a submittal register showing items of equipment and materials for which submittals are required by the specifications; this list may not be all inclusive and additional submittals may be required. The Government will provide the initial submittal register in electronic format. Thereafter, the Contractor shall maintain a complete list of all submittals, including completion of all data columns. Dates on which submittals are received and returned by the Government will be included in its export file to the Contractor. The Contractor shall track all submittals.

1.8 SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted

concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time a minimum of 14 calendar days exclusive of mailing time shall be allowed and shown on the register for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals. Submittals which do not clearly identify the products/accessories planned to be used under this contract shall be returned without any action.

1.9 TRANSMITTAL FORM (ENG FORM 4025)

The sample transmittal form (ENG Form 4025) attached to this section shall be used for submitting both Government approved and information only submittals in accordance with the instructions on the reverse side of the form. These forms will be furnished to the Contractor. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care shall be exercised to ensure proper listing of the specification paragraph and/or sheet number of the contract drawings pertinent to the data submitted for each item.

1.10 SUBMITTAL PROCEDURES

Submittals shall be made as follows:

1.10.1 Procedures

Send a minimum of six copies of each submittal to the Corps of Engineers at Baltimore District.

1.10.2 Deviations

For submittals which include proposed deviations requested by the Contractor, the column "variation" of ENG Form 4025 shall be checked. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted deviations.

1.11 CONTROL OF SUBMITTALS

The Contractor shall carefully control his procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register."

1.12 GOVERNMENT APPROVED SUBMITTALS

Upon completion of review of submittals requiring Government approval, the submittals will be identified as having received approval by being so stamped and dated. Three copies of the submittal will be retained by the Contracting Officer and three copies of the submittal will be returned to the Contractor.

1.13 INFORMATION ONLY SUBMITTALS

Normally submittals for information only will not be returned. Approval of the Contracting Officer is not required on information only submittals. The Government reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring

removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe.

1.14 STAMPS

Stamps used by the Contractor on the submittal data to certify that the submittal meets contract requirements shall be similar to the following:

CONTRACTOR
(Firm Name)
_____ Approved
_____ Approved with corrections as noted on submittal data and/or attached sheets(s).
SIGNATURE: _____
TITLE: _____
DATE: _____

-- End of Section --

SUBMITTAL REGISTER

TITLE AND LOCATION					CONTRACTOR											
GATED SPILLWAY/ELECTRICAL & CONTROL UPGRADE, RAYSTOWN LAKE, PA					LAKE, PA											
TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH#	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
					SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(r)
	01010	SD-01 Preconstruction Submittals														
		Title Evidence		FIO												
		Invoice Copies		FIO												
		Payment Evidence		FIO												
		Checklist			G AR											
		OSHA Log	1.3.1.4	FIO												
		CQC Program	1.5.1	G AR												
		Photographs	1.1.5	FIO												
		SD-05 Design Data														
		Change Notification		FIO												
		Progress Schedule	1.1.1	G AR												
		Modified Chart		G AR												
	01200	SD-04 Samples														
		Sample Tags	1.7.1.2	FIO												
	05120	SD-02 Shop Drawings														
		Erection Plan	1.6.2.1	G												
		Fabrication drawings	1.6.1	G												
		SD-06 Test Reports														
		Bolts, nuts, and washers	2.2	G G												
		SD-07 Certificates														
		Steel	2.1	G												
		Bolts, nuts, and washers	2.2	G												
		Welding electrodes and rods	2.3.1	G												
		Nonshrink grout	2.3.2	G												
		Galvanizing	2.4	G												
		AISC Quality Certification	1.5	G												

CONTRACT NO.

PAGE 2 OF 5 PAGES

CONTRACTOR LAKE, PA																
TITLE AND LOCATION GATED SPILLWAY/ELECTRICAL & CONTROL UPGRADE, RAYSTOWN LAKE, PA					CONTRACTOR: SCHEDULE DATES											
TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH#	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
					SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION	ACTION		(m)	(n)	(o)	(p)		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(r)
		15070	Vibration and noise isolation components	3.1.1	FIO											
		15080	SD-03 Product Data General Materials	2.1	G											
		15182	SD-03 Product Data Refrigerant Piping System	2.3	FIO											
		15700	SD-02 Shop Drawings Drawings		G											
			SD-03 Product Data Unitary Equipment	2.4	G											
			Posted Instructions	3.5	G											
			Verification of Dimensions	1.5.1	G											
			System Performance Tests	3.4	FIO											
			Demonstrations	3.5	G											
			SD-06 Test Reports													
			Refrigerant Tests, Charging, and Start-Up	3.3	G											
			System Performance Tests	3.4	G											
			SD-10 Operation and Maintenance Data													
			Operation Manuals		G											
			Maintenance Manuals	3.5	FIO											
		16410	SD-02 Shop Drawings Automatic Transfer Switches		G											
			Equipment	1.3.1	G											
			Installation	3.1	G											

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION					CONTRACTOR													
GATED SPILLWAY/ELECTRICAL & CONTROL UPGRADE, RAYSTOWN LAKE, PA					LAKE, PA													
ACTIVITY	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH#	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION	ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	DATE OF ACTION	DATE OF ACTION			
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)	
		16410	SD-03 Product Data															
			Material	1.3.1	G													
			Equipment	1.3.1	G													
			SD-06 Test Reports															
			Testing	2.4	G													
			SD-07 Certificates															
			Equipment	1.3.1	G													
			Material	1.3.1	G													
			Switching Equipment		G													
			SD-10 Operation and Maintenance															
			Data															
			Switching Equipment		G													
			Instructions	3.2	G													
	16415		SD-02 Shop Drawings															
			Interior Electrical Equipment		G													
			SD-03 Product Data															
			Manufacturer's Catalog		G													
			Material and Equipment		G													
			Installation Procedures		G													
			As-Built Drawings		G													
			Onsite Tests	3.20.2	G													
			SD-06 Test Reports															
			Factory Test Reports		G													
			Field Test Plan		G													
			Field Test Reports	3.18	G													
			SD-07 Certificates															

TRANSMITTAL OF SHOPDRAWINGS, EQUIPMENT DATA, MATERIAL SAMPLES, OR MANUFACTURER'S CERTIFICATES OF COMPLIANCE <i>(Read instructions on page two prior to initiating this form)</i>				DATE: Mo / Day / Yr / /		TRANSMITTAL NO --
SECTION I - REQUEST FOR APPROVAL OF THE FOLLOWING ITEMS <i>(This section will be initiated by the contractor)</i>						
TO:		FROM:		CONTRACT NO. DAC		CHECK ONE: <input type="checkbox"/> THIS IS A NEW SUBMITTAL <input type="checkbox"/> THIS IS A RESUBMITTAL OF TRANSMITTAL
SPECIFICATION SEC NO. <i>(Cover only one section with each transmittal)</i>		PROJECT TITLE AND LOCATION				
ITEM NO.	DESCRIPTION OF ITEM SUBMITTED <i>(Type size, model number/etc.)</i>	MFG OR CONTR. CAT., CURVE DRAWING OR BROCHURE NO. <i>(See instruction no. 8)</i>	NO. OF COPIES	CONTRACT SPEC. PARA NO.	REFERENCE MENT. DRAWING SHEET NO.	FOR CONTR- ACTOR USE CODE
a.	b.	c.	d.	e.	f.	h. i.
REMARKS		I certify that the above submitted items have been reviewed in detail and are correct and in strict compliance with the contract drawings and specifications except as other wise stated.				
		NAME AND SIGNATURE OF THE CONTRACTOR				
SECTION II - APPROVAL ACTION						
ENCLOSURES RETURNED <i>(List by Item No.)</i>		NAME, TITLE OF APPROVING AUTHORITY			DATE	

INSTRUCTIONS

1. Section I will be initiated by the Contractor in the required numbers of copies.
2. Each transmittal shall be numbered consecutively in the space provided for "Transmittal No.". This number in addition to the contract number, will form a serial number for identifying each submittal. For new submittals or resubmittals mark the appropriate box; on resubmittals, insert transmittal number of last submission as well as the new submittal number.
3. The "Item No." will be the same "Item No." as indicated on ENG FORM 4288 for each entry on this form.
4. Submittals requiring expeditious handling will be submitted under a separate form.
5. Separate transmittal form will be used for submittals under separate sections of the specifications.
6. A check shall be placed in the "Variation" column when a submittal is not in accordance with the plans and specifications -- also a written statement to that effect shall be included in the space provided for "Remarks".
7. Form is self transmitting, letter of transmittal is not required.
8. When a sample of a material or Manufacturer's Certificate of Compliance is transmitted, indicate "Sample" or "Certificate" in column c, Section I
9. U.S. Army Corps of Engineers approving authority will assign action codes as indicated below in space provided in Section I, column I to each item submitted. In addition they will ensure enclosures are indicated and attached to the form prior to return to the contractor. The Contractor will assign action codes as indicated in Section I, Column g, to each item submitted.

THE FOLLOWING ACTION CODES ARE GIVEN TO ITEMS SUBMITTED

A --	Approved as submitted	E --	Disapproved (See Attached)
B --	Approved, except as noted on drawings.	F --	Receipt acknowledged
C --	Approved except as noted on drawings. Refer to attached sheet resubmission required.	FX --	Receipt acknowledged, does not comply as noted with contract requirements
D --	Will be returned by separate correspondence.	G --	Other (Specify)

10. Approval of items does not relieve the contractor from complying with all the requirements of the contract plans and specifications.

SECTION 01420

SOURCES FOR REFERENCE PUBLICATIONS

PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the standards producing organization, (e.g. ASTM B 564 Nickel Alloy Forgings). However, when the standards producing organization has not assigned a number to a document, an identifying number has been assigned for reference purposes.

1.2 ORDERING INFORMATION

The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the standards producing organization should be ordered from the source by title rather than by number.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

4301 North Fairfax Dr., Suite 425

ATTN: Pubs Dept.

Arlington, VA 22203

Ph: 703-524-8800

Fax: 703-528-3816

E-mail: ari@ari.org

Internet: www.ari.org

AOK 6/00

LOK 6/00

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

30 W. University Dr.

Arlington Heights, IL 60004-1893

Ph: 847-394-0150

Fax: 847-253-0088

Internet: www.amca.org

AOK 6/00

LOK 6/00

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

One East Wacker Dr., Suite 3100

Chicago, IL 60601-2001

Ph: 312-670-2400

Publications: 800-644-2400

Fax: 312-670-5403

Internet: www.aisc.org

AOK 6/00
LOK 6/00

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

11 West 42nd St
New York, NY 10036
Ph: 212-642-4900
Fax: 212-398-0023
Internet: www.ansi.org/
Note: Documents beginning with the letter "S" can be ordered from:
Acoustical Society of America
P. O. Box 1020
Sweickley, PA 15143-9998
Ph: 412-741-1979
Fax: 412-741-0609
Internet: asa.aip.org
AOK 6/00
LOK 6/00

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
Ph: 610-832-9585
Fax: 610-832-9555
Internet: www.astm.org
AOK 6/00
LOK 6/00

NOTE: The annual ASTM Book of Standards (66 Vol) is
available for \$3500.00. Prices of individual standards vary.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

1791 Tullie Cir., NE
Atlanta, GA 30329
Ph: 800-527-4723 or 404-636-8400
Fax: 404-321-5478
Internet: <http://www.ashrae.org>
AOK 6/00
LOK 6/00

AMERICAN WELDING SOCIETY (AWS)

550 N.W. LeJeune Road
Miami, FL 33126
Ph: 800-443-9353 - 305-443-9353
Fax: 305-443-7559
Internet: <http://www.amweld.org>
AOK 6/00
LOK 6/00

ASME INTERNATIONAL (ASME)

Three Park Avenue
New York, NY 10016-5990

Ph: 212-591-7722
Fax: 212-591-7674
Internet: www.asme.org
AOK 8/00
LOK 6/00

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

2500 Wilson Blvd.
Arlington, VA 22201-3834
Ph: 703-907-7500
Fax: 703-907-7501
Internet: www.eia.org
AOK 8/00
LOK 6/00

IBM CORPORATION (IBM)

Publications
P.O. Box 29570
Raleigh, NC 27626-0570
Ph: 800-879-2755, Option 1
Fax: 800-445-9269
Internet: www.elink.ibm.link.ibm.com/pbl/pbl
AOK 8/00
LOK 6/00

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

445 Hoes Ln, P. O. Box 1331
Piscataway, NJ 08855-1331
Ph: 732-981-0060 OR 800-701-4333
Fax: 732-981-9667
Internet: www.ieee.org
E-mail: customer.service@ieee.org
AOK 8/00
LOK 6/00

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

P.O. Box 440
South Yarmouth, MA 02664
Ph: 508-394-4424
Fax: 508-394-1194
E-mail: Internet: www.icea.net
AOK 8/00
LOK 6/00

INTERNATIONAL TELECOMMUNICATION UNION (ITU)

Order from:
U.S. Dept of Commerce
National Technical Information Service
5285 Port Royal Road.
Springfield, VA 22161
Ph: 703605-6040
FAX: 703-605-6887
Internet: www.ntis.gov
For documents not avail from Dept of Commerce:

E-Mail: sales@itu.ch
Fax: 41.22.730.5194
Internet: www.itu.org
AOK 8/00
LOK 6/00

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

127 Park St., NE
Vienna, VA 22180-4602
Ph: 703-281-6613
Fax: 703-281-6671
Internet: www.mss-hq.com
e-mail: info@mss-hq.com
AOK 8/00
LOK 6/00

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

2017 So. 139th Cir.
Omaha, NE 68144
Ph: 402-342-3463
Fax: 402-330-9702
Internet: www.micainsulation.org
e-mail: info@micainsulation.org
AOK 8/00
LOK 6/00

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

1300 N. 17th St., Suite 1847
Rosslyn, VA 22209
Ph: 703-841-3200
Fax: 703-841-3300
Internet: http://www.nema.org/
AOK 8/00
LOK 6/00

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

1 Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
Ph: 617-770-3000
Fax: 617-770-0700
Internet: www.nfpa.org
NOTE: The complete set of 1997 NFPA National Fire Codes (13 Vol.)
is available for \$835.00.
AOK 8/00
LOK 8/00

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

4201 Lafayette Center Dr.,
Chantilly, VA 20151-1209
Ph: 703-803-2980
Fax: 703-803-3732

Internet: <http://www.smacna.org>
e-mail: info@smacna.org
AOK 8/00
LOK 6/00

UNDERWRITERS LABORATORIES (UL)

333 Pfingsten Rd.
Northbrook, IL 60062-2096
Ph: 847-272-8800
Fax: 847-272-8129
Internet: <http://www.ul.com/>
e-mail: northbrook@us.ul.com
AOK 8/00
LOK 6/00

Note: First price is for the standard only. Second price is for the standard including the Revision Subscription Service.

-- End of Section --

SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC FCD	(1995a) Quality Certification Program Description
AISC 316	(1989) ASD Manual of Steel Construction
AISC 317	(1992; Errata 1994) Connections
AISC 326	(2002) Detailing for Steel Construction
AISC 303	(2000) Steel Buildings and Bridges
AISC 348	(2000) Structural Joints Using ASTM A325 or A490 Bolts
AISC 335	(1989) Structural Steel Buildings Allowable Stress Design and Plastic Design
AISC S340	(1992) Metric Properties of Structural Shapes with Dimensions According to ASTM A6M

ASME INTERNATIONAL (ASME)

ASME B46.1	(2002) Surface Texture, (Surface Roughness, Waviness, and Lay)
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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M	(2003) General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 36/A 36M	(2002) Carbon Structural Steel
ASTM A 53	(2002) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 123/A 123M	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 143	(2003) Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel

Products and Procedure for Detecting
Embrittlement

ASTM A 153/A 153M	(2003) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 325	(2002) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 490	(2002) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 563	(2000) Carbon and Alloy Steel Nuts
ASTM A 572/A 572M	(2003) High-Strength Low-Alloy Columbium-Vanadium of Structural Steel
ASTM A 780	(2001) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM C 827	(2001; Rev A) Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
ASTM C 1107	(2002) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM F 436	(2002) Hardened Steel Washers

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1998) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2002) Structural Welding Code - Steel

1.2 SYSTEM DESCRIPTION

Provide the structural steel system, including galvanizing, complete and ready for use. Structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing shall be provided in accordance with AISC 316 and AISC 317 except as modified in this contract.

1.3 MODIFICATIONS TO REFERENCES

AISC 335, AISC 303, AISC 348, and AISC S340, except as modified in this section, shall be considered a part of AISC 316 and AISC 317 and are referred to in this section as AISC 316 and AISC 317.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Erection Plan, including description of temporary supports; G

Fabrication drawings including description of connections; G

SD-06 Test Reports

Bolts, nuts, and washers; G

Supply the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners; G

SD-07 Certificates

Steel; G

Bolts, nuts, and washers; G

Welding electrodes and rods; G

Nonshrink grout; G

Galvanizing; G

AISC Quality Certification; G

Welding procedures and qualifications; G

Slide bearings; G

1.5 AISC QUALITY CERTIFICATION

Work shall be fabricated in an AISC certified Category Sbd fabrication plant.

1.6 QUALITY ASSURANCE

1.6.1 Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 326, AISC 316 and AISC 317. Drawings shall not be reproductions of contract drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols.

1.6.2 Certifications

1.6.2.1 Erection Plan

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing, and a detailed sequence of welding, including each welding procedure required.

1.6.2.2 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welding operator is more than one-year old, the welding operator's qualification certificate shall be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.

PART 2 PRODUCTS

2.1 STEEL

2.1.1 Structural Steel (Angles and Plates)

ASTM A 36/A 36M.

2.1.2 High-Strength Structural Steel

2.1.2.1 Low-Alloy Steel (Wide Flange)

ASTM A992.

2.1.2.2 Low-Alloy Steel (Channels)

ASTM A 572/A 572M, Grade 50.

2.1.3 Steel Pipe

ASTM A 53, Type E or S, Grade B, weight class STD (Standard).

2.2 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

2.2.1 Structural Steel, Steel Pipe

2.2.1.1 Bolts

ASTM A 325, Type 1. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.2.1.2 Nuts

ASTM A 563, Grade and Style for applicable ASTM bolt standard recommended.

2.2.1.3 Washers

ASTM F 436 washers for ASTM A 325 and ASTM A 490 bolts.

2.2.2 High-Strength Structural Steel and Structural Steel Tubing

2.2.2.1 Bolts

ASTM A 325, Type 1.

2.2.2.2 Nuts

ASTM A 563, Grade and Style as specified in the applicable ASTM bolt standard.

2.2.2.3 Washers

ASTM F 436, plain carbon steel.

2.3 STRUCTURAL STEEL ACCESSORIES

2.3.1 Welding Electrodes and Rods

AWS D1.1/D1.1M.

2.3.2 Nonshrink Grout

ASTM C 1107, with no ASTM C 827 shrinkage.

2.3.3 Slide Bearings

Self-lubricating bearing elements consisting of 100% virgin polytetrafluoroethylene polymer and reinforcing aggregates prebonded to carbon steel backing. The principal constituent of the aggregate shall be ground glass fibers. The coefficient of static friction of the material to itself shall be .06 from initial installation and shall not deform more than .002" under allowable static load. The bond between the material and the steel shall be heat cured, high temperature epoxy capable of temperatures of -320°F to +400°F.

2.4 GALVANIZING

ASTM A 123/A 123M or ASTM A 153/A 153M, as applicable, unless specified otherwise galvanize after fabrication where practicable.

2.5 FABRICATION

2.5.1 Markings

Prior to erection, members shall be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded or on surfaces of weathering steels that will be exposed in the completed structure. Do not locate match markings in areas that will decrease member strength or cause stress concentrations. Affix embossed tags to hot-dipped galvanized members.

2.5.2 Surface Finishes

ASME B46.1 maximum surface roughness of 125 for pin, pinholes, and sliding bearings, unless indicated otherwise.

PART 3 EXECUTION

3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC 316. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC

FCD for Category b structural steelwork. Compression joints depending on contact bearing shall have a surface roughness not in excess of 500 micro inches as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6/A 6M.

3.2 ERECTION

- a. Erection of structural steel, except as indicated in item b. below, shall be in accordance with the applicable provisions of AISC 316. Erection plan shall be reviewed, stamped and sealed by a licensed structural engineer.
- b. Provide for drainage in structural steel. After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with manufacturer's instructions.

3.2.1 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

3.3 CONNECTIONS

Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Punch, subpunch and ream, or drill bolt and pin holes. Bolts, nuts, and washers shall be clean of dirt and rust, and lubricated immediately prior to installation.

3.3.1 High-Strength Bolts

ASTM A 325 and ASTM A 490 bolts shall be snug tightened.

3.4 WELDING

AWS D1.1/D1.1M. Provide AWS D1.1/D1.1M qualified welders, welding operators, and tackers.

The contractor shall develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Prequalified procedures may be submitted for information only; however, procedures that are not prequalified shall be submitted for approval.

3.4.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips

Removal is not required.

3.5 GALVANIZING REPAIR

Provide as indicated or specified. Galvanize after fabrication where practicable. Repair damage to galvanized coatings using ASTM A 780 zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

3.6 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required

for testing. The COR shall be notified in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of weld inspection.

3.6.1 Welds

3.6.1.1 Visual Inspection

AWS D1.1/D1.1M. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. Welding inspectors shall visually inspect and mark welds, including fillet weld end returns.

3.6.1.2 Nondestructive Testing

AWS D1.1/D1.1M. Test locations shall be selected by the Contracting Officer. If more than 25 percent of welds made by a welder contain defects identified by testing, then all welds made by that welder shall be tested by radiographic or ultrasonic testing, as approved by the Contracting Officer. When all welds made by an individual welder are required to be tested, magnetic particle testing shall be used only in areas inaccessible to either radiographic or ultrasonic testing. Retest defective areas after repair.

- a. Testing frequency: Provide the following types and number of tests:

<u>Test Type</u>	<u>Number of Tests</u>
Dye Penetrant	25%

3.6.2 High-Strength Bolts

3.6.2.1 Inspection

Inspection procedures shall be in accordance with AISC 348, Section 9. Confirm and report to the COR that the materials meet the project specification and that they are properly stored. Confirm that the faying surfaces have been properly prepared before the connections are assembled. Observe the specified job site testing and calibration, and confirm that the procedure to be used provides the required tension. Monitor the work to ensure the testing procedures are routinely followed on joints that are specified to be fully tensioned.

3.6.3 Testing for Embrittlement

ASTM A 143 for steel products hot-dip galvanized after fabrication.

-- End of Section --

SECTION 05500

MISCELLANEOUS METAL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2001) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 36/A 36M	(2000a) Carbon Structural Steel
ASTM A 467/A 467M	(1998) Machine and Coil Chain
ASTM A 53/A 53M	(2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 653/A 653M	(2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 924/A 924M	(1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2000) Structural Welding Code - Steel
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1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Miscellaneous Metal Items; G.

Detail drawings indicating material thickness, type, grade, and class; dimensions; and construction details. Drawings shall include catalog cuts, erection details, manufacturer's descriptive data and installation instructions, and templates.

1.3 GENERAL REQUIREMENTS

The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1/D1.1M. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123/A 123M, ASTM A 653/A 653M, or ASTM A 924/A 924M, as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

1.4 DISSIMILAR MATERIALS

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint or asphalt varnish or separated with neoprene (where noted).

1.5 WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish, and unless otherwise approved, exposed riveting shall be flush. Where tight fits are required, joints shall be milled. Corner joints shall be coped or mitered, well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

1.6 ANCHORAGE

Anchorage shall be provided where necessary for fastening miscellaneous metal items securely in place.

PART 2 PRODUCTS

2.1 FLOOR GRATINGS AND FRAMES

Edges shall be banded with bars 1/4 inch less in height than bearing bars for grating sizes above 3/4 inch. Banding bars shall be flush with the top of bearing grating. Frames shall be of welded steel construction finished to match the grating. Floor gratings and frames shall be galvanized after fabrication.

2.2 HANDRAILS

2.2.1 Steel Handrails, Including Carbon Steel Inserts

Steel handrails, including inserts in concrete, shall be steel pipe conforming to ASTM A 53/A 53M. Railings shall be hot-dip galvanized. Pipe collars shall be hot-dip galvanized steel.

- a. Joint posts, rail, and corners shall be fabricated by one of the following methods:

- (1) Flush type rail fittings of commercial standard, welded and ground smooth with railing splice locks secured with 3/8 inch hexagonal recessed-head setscrews.

- (2) Mitered and welded joints by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding smooth. Railing splices shall be butted and reinforced by a tight fitting interior sleeve not less than 6 inches long.

- b. Removable sections, toe-boards, and brackets shall be provided as indicated.

2.3 MISCELLANEOUS

Miscellaneous plates and shapes for items that do not form a part of the structural steel framework shall be provided to complete the work.

2.4 SAFETY CHAINS

Safety chains shall be galvanized welded steel, proof coil chain tested in accordance with ASTM A 467/A 467M, Class CS. Safety chains shall be straight link style, 3/16 inch diameter, minimum 12 links per foot and with bolt type snap hooks on each end. Eye bolts for attachment of chains shall be galvanized 3/8 inch bolt with 3/4 inch eye, anchored as indicated. Three chains shall be furnished for each guarded opening.

2.5 STEEL STAIRS

Steel stairs shall be complete with structural or formed channel stringers, slip-resistant metallic treads, and necessary bolts and other fastenings as indicated. Structural steel shall conform to ASTM A 36/A 36M. Stairs and accessories shall be galvanized. Steel stair treads and their connection to stringers shall be designed to withstand a uniform live load of 100 psf and a 300 lb concentrated load acting at any point (these loads need not be applied simultaneously).

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

All items shall be installed at the locations shown and according to the manufacturer's recommendations. Items listed below require additional procedures as specified.

3.2 ATTACHMENT OF HANDRAILS

Toeboards and brackets shall be installed where indicated. Splices, where

required, shall be made at expansion joints. Removable sections shall be installed as indicated.

3.2.1 Installation of Steel Handrails

Installation shall be as shown on structural drawings.

3.3 MOUNTING OF SAFETY CHAINS

Safety chains shall be mounted as shown on structural drawings.

-- End of Section --

SECTION 07600

FLASHING AND SHEET METAL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 653/A 653M	(2001, Rev A) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 32	(2000) Solder Metal
ASTM B 69	(2001, Rev A) Rolled Zinc
ASTM B 209	(2001) Aluminum and Aluminum Alloy Sheet and Plate
ASTM B 221	(2000) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 370	(1998) Copper Sheet and Strip for Building Construction
ASTM D 41	(1994) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 226	(1997, Rev A) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 1784	(1999, Rev A) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 4586	(2000) Asphalt Roof Cement, Asbestos-Free
AMERICAN WELDING SOCIETY (AWS)	
AWS D1.2	(1997) Structural Welding Code Aluminum

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Arch. Manual	(1993) Architectural Sheet Metal Manual
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1.2 General Requirements

Sheet metalwork shall be accomplished to form weathertight construction without waves, warps, buckles, fastening stresses or distortion, and shall allow for expansion and contraction. Cutting, fitting, drilling, and other

operations in connection with sheet metal required to accommodate the work of other trades shall be performed by sheet metal mechanics.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Flashing at roof penetrations; G

SD-11 Closeout Submittals

Quality Control Plan

Submit for sheet metal work in accordance with paragraph entitled "Field Quality Control."

1.4 DELIVERY, HANDLING, AND STORAGE

Package and protect materials during shipment. Uncrate and inspect materials for damage, dampness, and wet-storage stains upon delivery to the job site. Remove from the site and replace damaged materials that cannot be restored to like-new condition. Handle sheet metal items to avoid damage to surfaces, edges, and ends. Store materials in dry, weather-tight, ventilated areas until immediately before installation.

PART 2 PRODUCTS

2.1 MATERIALS

Lead, lead-coated metal, and galvanized steel shall not be used. Any metal listed by SMACNA Arch. Manual for a particular item may be used, unless otherwise specified or indicated. Materials shall conform to the requirements specified below and to the thicknesses and configurations established in SMACNA Arch. Manual. Different items need not be of the same metal, except that if copper is selected for any exposed item, all exposed items shall be copper.

Furnish sheet metal items in 8 to 10 foot lengths. Single pieces less than 8 feet long may be used to connect to factory-fabricated inside and outside corners, and at ends of runs. Factory fabricate corner pieces with minimum 12 inch legs. Provide accessories and other items essential to complete the sheet metal installation. These accessories shall be made of the same materials as the items to which they are applied. Fabricate sheet metal items of the materials specified below and to the gage, thickness, or weight shown in Table I at the end of this section. Sheet metal items shall have mill finish unless specified otherwise. Where more than one material is listed for a particular item in Table I, each is acceptable and may be used except as follows:

2.1.1 Exposed Sheet Metal Items

Shall be of the same material. The following items shall be considered as

exposed sheet metal: gutters, including hangers; downspouts; gravel stops and fascias; cap, valley, steeped, base, and eave flashings and related accessories.

2.1.2 Drainage

Do not use copper for an exposed item if drainage from that item will pass over exposed masonry, stonework or other metal surfaces. In addition to the metals listed in Table I, lead-coated copper may be used for such items.

2.1.3 Copper, Sheet and Strip

ASTM B 370, cold-rolled temper, H 00 (standard).

2.1.4 Steel Sheet, Zinc-Coated (Galvanized)

ASTM A 653/A 653M.

2.1.4.1 Finish

Exposed exterior items of zinc-coated steel sheet shall have a baked-on, factory-applied color coating of polyvinylidene fluoride or other equivalent fluorocarbon coating applied after metal substrates have been cleaned and pretreated. Finish coating dry-film thickness shall be 0.8 to 1.3 mils.

2.1.5 Zinc Sheet and Strip

ASTM B 69, Type I, a minimum of 0.024 inch thick.

2.1.6 Aluminum Alloy Sheet and Plate

ASTM B 209, anodized clear form alloy, and temper appropriate for use.

2.1.6.1 Finish

Exposed exterior sheet metal items of aluminum shall have a baked-on, factory-applied color coating of polyvinylidene fluoride (PVF2) or other equivalent fluorocarbon coating applied after metal substrates have been cleaned and pretreated. Finish coating dry-film thickness shall be 0.8 to 1.3 mils.

2.1.7 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes

ASTM B 221.

2.1.8 Solder

ASTM B 32, 95-5 tin-antimony.

2.1.9 Polyvinyl Chloride Reglet

ASTM D 1784, Type II, Grade 1, Class 14333-D, 0.075 inch minimum thickness.

2.1.10 Bituminous Plastic Cement

ASTM D 4586, Type I.

2.1.11 Building Paper

ASTM D 226 Type I.

2.1.12 Asphalt Primer

ASTM D 41.

2.1.13 Fasteners

Use the same metal or a metal compatible with the item fastened. Use stainless steel fasteners to fasten dissimilar materials.

2.2 LOUVERS

2.2.1 Materials

- a. Aluminum Extrusions: ASTM B 221M, alloy 6063-T5 or T-52.
- b. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.

2.2.2 Fabrication, General

- a. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

2.2.3 Fixed, Extruded-Aluminum Louvers

- a. Horizontal Storm-Resistant Louver:
 - 1. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.2.4 Louver Screens

- a. General: Provide screen at each exterior louver.
- b. Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 150 mm from each corner and at 300 mm o.c.

2.2.5 Finishes, General

- a. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- b. Finish louvers after assembly.

2.2.6 Aluminum Finishes

- a. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
- b. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte;

Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611. Bronze anodized to matching existing building trim.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Workmanship

Make lines, arrises, and angles sharp and true. Free exposed surfaces from visible wave, warp, and buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections which might affect the application. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA Arch. Manual, Architectural Sheet Metal Manual. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight. Join sheet metal items together as shown in Table II.

3.1.2 Nailing

Confine nailing of sheet metal generally to sheet metal having a maximum width of 18 inches. Confine nailing of flashing to one edge only. Space nails evenly not over 3 inches on centers and approximately 1/2 inch from edge unless otherwise specified or indicated. Face nailing will not be permitted. Where sheet metal is applied to other than wood surfaces, include in shop drawings, the locations for sleepers and nailing strips required to secure the work. Sleepers and nailing strips are specified in Section 06100N, "Rough Carpentry."

3.1.3 Cleats

Provide cleats for sheet metal 18 inches and over in width. Space cleats evenly not over 12 inches on centers unless otherwise specified or indicated. Unless otherwise specified, cleats shall be not less than 2 inches wide by 3 inches long and of the same material and thickness as the sheet metal being installed. Secure one end of the cleat with two nails and the cleat folded back over the nailheads. Lock the other end into the seam. Where the fastening is to be made to concrete or masonry, screws shall be used and shall be driven in expansion shields set in concrete or masonry. Pretin cleats for soldered seams.

3.1.4 Bolts, Rivets, and Screws

Install bolts, rivets, and screws where indicated or required. Provide compatible washers where required to protect surface of sheet metal and to provide a watertight connection. Joints in aluminum sheets 0.040 inch or less in thickness shall be mechanically made.

3.1.5 Seams

Straight and uniform in width and height with no solder showing on the face.

3.1.5.1 Flat-lock Seams

Finish not less than 3/4 inch wide.

3.1.5.2 Lap Seams

Finish soldered seams not less than one inch wide. Overlap seams not soldered, not less than 3 inches.

3.1.5.3 Loose-Lock Expansion Seams

Not less than 3 inches wide; provide minimum one inch movement within the joint. Completely fill the joints with the specified sealant, applied at not less than 1/8 inch thick bed. Sealants are specified in Section 07920N, "Joint Sealants."

3.1.5.4 Standing Seams

Not less than one inch high, double locked without solder.

3.1.5.5 Flat Seams

Make seams in the direction of the flow.

3.1.6 Soldering

Where soldering is specified, it shall apply to copper, terne-coated stainless steel, zinc-coated steel, and stainless steel items. Edges of sheet metal shall be pretinned before soldering is begun. Seal the joints in aluminum sheets of 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

3.1.6.1 Edges

Scrape or wire-brush the edges of lead-coated material to be soldered to produce a bright surface. Flux brush the seams in before soldering. Treat with soldering acid flux the edges of stainless steel to be pretinned. Seal the joints in aluminum sheets of 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

3.1.7 Welding and Mechanical Fastening

Use welding for aluminum of thickness greater than 0.040 inch. Aluminum 0.040 inch or less in thickness shall be butted and the space backed with formed flashing plate; or lock joined, mechanically fastened, and filled with sealant as recommended by the aluminum manufacturer.

3.1.7.1 Welding of Aluminum

Use welding of the inert gas, shield-arc type. For procedures, appearance and quality of welds, and the methods used in correcting welding work, conform to AWS D1.2.

3.1.7.2 Mechanical Fastening of Aluminum

Use No. 12, aluminum alloy, sheet metal screws or other suitable aluminum alloy or stainless steel fasteners. Drive fasteners in holes made with a No. 26 drill in securing side laps, end laps, and flashings. Space fasteners 12 inches maximum on centers. Where end lap fasteners are

required to improve closure, locate the end lap fasteners not more than 2 inches from the end of the overlapping sheet.

3.1.8 Protection from Contact with Dissimilar Materials

3.1.8.1 Copper or Copper-bearing Alloys

Paint with heavy-bodied bituminous paint surfaces in contact with dissimilar metal, or separate the surfaces by means of moistureproof building felts.

3.1.8.2 Aluminum

Aluminum surfaces shall not directly contact other metals except stainless steel, zinc, or zinc coating. Where aluminum contacts another metal, paint the dissimilar metal with a primer followed by two coats of aluminum paint. Where drainage from a dissimilar metal passes over aluminum, paint the dissimilar metal with a non-lead pigmented paint.

3.1.8.3 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.8.4 Wood or Other Absorptive Materials

Paint surfaces that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

3.1.9 Expansion and Contraction

Provide expansion and contraction joints at not more than 32 foot intervals for aluminum and at not more than 40 foot intervals for other metals. Where the distance between the last expansion joint and the end of the continuous run is more than half the required interval, an additional joint shall be provided. Space joints evenly. Join extruded aluminum gravel stops and fascias by expansion and contraction joints spaced not more than 12 feet apart.

3.1.10 Base Flashing

Extend up vertical surfaces of the flashing not less than 8 inches and not less than 4 inches under the roof covering. Where finish wall coverings form a counterflashing, extend the vertical leg of the flashing up behind the applied wall covering not less than 6 inches. Overlap the flashing strips with the previously laid flashing not less than 3 inches. Fasten the strips at their upper edge to the deck. Horizontal flashing at vertical surfaces must extend vertically above the roof surface and fastened at their upper edge to the deck a minimum of 6 inches o.c. with hex headed, galvanized shielded screws a minimum of 2-inch lap of any surface. Solder end laps and provide for expansion and contraction. Extend the metal flashing over crickets at the up-slope side of curbs, vertical surfaces extending through sloping roofs, the metal flashings. Extend the metal flashings onto the roof not less than 4.5 inches. Install and fit the flashings so as to be completely weathertight. Base flashing for interior and exterior corners shall be factory-fabricated.

3.1.11 Counterflashing

Except where indicated or specified otherwise, insert counterflashing in reglets located from 9 to 10 inches above roof decks, extend down vertical surfaces over upturned vertical leg of base flashings not less than 3 inches.

Fold the exposed edges of counterflashings 1/2 inch. Where stepped counterflashings are required, they may be installed in short lengths a minimum 8 inch by 8 inch or may be of the preformed one-piece type. Provide end laps in counterflashings not less than 3 inches and make it weathertight with plastic cement. Do not make lengths of metal counterflashings exceed 10 feet. Form the flashings to the required shapes before installation. Factory-form the corners not less than 12 inches from the angle. Secure the flashings in the reglets with lead wedges and space not more than 18 inches apart; on short runs, place wedges closer together. Fill caulked-type reglets or raked joints which receive counterflashing with caulking compound. Caulking is covered in Section 07920N, "Joint Sealants." Turn up the concealed edge of counterflashings built into masonry or concrete walls not less than 1/4 inch and extend not less than 2 inches into the walls. Install counterflashing to provide a spring action against base flashing.

3.1.12 Metal Reglets

Caulked type or friction type reglets shall be factory fabricated with a minimum opening of 1/4 inch and a depth of 1 1/4 inches, as approved.

3.1.12.1 Caulked Reglets

Provide with rounded edges and metal strap brackets or other anchors for securing to the concrete forms. Provide reglets with a core to protect them from injury during the installation. Provide built-up mitered corner pieces for internal and external angles. Wedge the flashing in the reglets with lead wedges every 18 inches, caulked full and solid with an approved compound.

3.1.12.2 Friction Reglets

Provide with flashing receiving slots not less than 5/8 inch deep, one inch jointing tongues, and upper and lower anchoring flanges installed at 24 inches maximum snaplock receiver. Insert the flashing the full depth of the slot and lock by indentations made with a dull-pointed tool, wedges, and filled with a sealant. For friction reglets, install flashing snaplock receivers at 24 inches o.c. maximum. When the flashing has been inserted the full depth, caulk the slot and lock with wedges and fill with sealant.

3.2 CLEANING

Clean exposed sheet metal work at completion of installation. Remove grease and oil films, handling marks, contamination from steel wool, fittings and drilling debris, and scrub-clean. Free the exposed metal surfaces of dents, creases, waves, scratch marks, and solder or weld marks.

3.3 REPAIRS TO FINISH

Scratches, abrasions, and minor surface defects of finish may be repaired in accordance with the manufacturer's printed instructions and as approved. Repair damaged surfaces caused by scratches, blemishes, and variations of color and surface texture. Replace items which cannot be repaired.

-- End of Section --

SECTION 11287

TAINTER GATE MOTORS

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Motors; G

Documentation certifying the construction and performance of the products.

1.2 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

1.3 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.4 PROJECT/SITE CONDITIONS

1.4.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.4.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

PART 2 PRODUCTS

2.1 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Motors shall be of the high efficiency type and shall have electrical characteristics as shown. Motor enclosures shall be totally enclosed, fan cooled, fungus treated for severe environments. Provide motor space heaters to prevent moisture condensation in the motor. Heater shall be sized to provide approximately a 10°C temperature rise above the ambient condition. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with the type of starter as indicated. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements.

3.2 SYSTEM PERFORMANCE TESTS

Tests to demonstrate the general operating characteristics of all equipment shall be conducted by an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than two cycles for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is functioning as specified. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. Field tests shall be coordinated with Section 13801 UTILITY MONITORING AND CONTROL SYSTEM (UMCS).

-- End of Section --

SECTION 13801

UTILITY MONITORING AND CONTROL SYSTEM (UMCS)

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced and are referred to in the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500-D (1998) Laboratory Methods of Testing
Dampers for Rating

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI X3.154 (1988; R 1994) Office Machines and
Supplies - Alphanumeric Machines-Keyboards
Arrangement

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE Hdbk-IP (1997) Handbook, Fundamentals I-P Edition

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA ANSI/EIA/TIA-232-F (1997) Interface Between Data Terminal
Equipment and Data Circuit-Terminating
Equipment Employing Serial Binary Data
Interchange

EIA ANSI/TIA/EIA-568-A (1995; Addendum 3 1998) Commercial
Building Telecommunications Cabling
Standard

EIA ANSI/TIA/EIA-606A (1993) Administration Standard for the
Telecommunications Infrastructure of
Commercial Buildings

EIA ANSI/TIA/EIA-607A (1994) Commercial Building Grounding and
Bonding Requirements for Telecommunications

EIA TIA/EIA-TSB-67 (1995) Transmission Performance
Specifications for Field Testing of
Unshielded Twisted-Pair Cabling Systems

IBM CORPORATION (IBM)

IBM GA27-3361-07 (1987) LAN Cabling System - Planning and
Installation

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 100	(1997) IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 142	(1991) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
IEEE Std 802.3	(1998) Local Area Networks: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
IEEE Std 802.4	(1998) Information Processing Systems, Local Area Networks: Part 4: Token Passing Bus Access Method and Physical Layer Specifications

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-80-576	(1994) Communications Wire and Cable for Wiring of Premises
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INTERNATIONAL TELECOMMUNICATION UNION (ITU)

ITU V.32 bis	(1991) A Duplex Modem Operating at Data Signalling Rates of up to 14 400 bit(s) for use on the General Switched Telephone Network and on Leased Point-to-Point 2-Wire Telephone-Type Circuits
ITU V.34	(1994) Data Communication Over the Telephone Network - A Modem Operating at Data Signaling Rates of up to 28,800 bits for use on the General Switched Telephone Network and on Leased Point-to-Point Two-Wire Telephone Type Circuits
ITU V.42	(1993) Data Communications Over the Telephone Network Error-Correcting Procedures for DCEs Using Asynchronous-to-Synchronous Conversion
ITU V.42 bis	(1990) Data Compression Procedures for Data Circuit Terminating Equipment (DCE) Using Error Correction Procedures

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ST 1	(1988) Specialty Transformers (Except General-Purpose Type)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-2202 (Rev A) Energy Monitoring and Control Systems, Factory Tests

MIL-STD-2203 (Rev A) Energy Monitoring and Control Systems, Performance Verification and Endurance Tests

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

47 CFR 68 Connection of Terminal Equipment to the Telephone Network

UNDERWRITERS LABORATORIES (UL)

UL 508 (1999) Industrial Control Equipment

UL 916 (1998) Energy Management Equipment

1.2 SYSTEM DESCRIPTION

The Utility Monitoring and Control System (UMCS) will be used to control operation of building and utility systems as specified and shown below in paragraph System Requirements.

1.2.1 System Requirements

The Contractor shall furnish the UMCS, in accordance with UL 916, configured as a distributed processing network of control and monitoring functions as shown and specified. All automatic controls provided under this specification shall utilize Direct Digital Control (DDC) and Supervisory Control as shown to provide the required sequences of operation. No pneumatic devices will be allowed. UMCS panels shall manage control and monitoring functions for equipment shown. The system shall provide for operator interaction, overall system supervision, coordination, control, and monitoring. The system shall provide monitoring and control functions shown and as required to accomplish operational sequences shown. Sensed data shall be obtained by the Smart Field Panels, Unitary Controllers, and Universal Programmable Controllers, collectively referred to as Field Equipment Panels (FEP), using instruments and controls interfaced to mechanical, and electrical systems as shown and specified. All required setpoints, settings, alarm limits, and sequences of operation shall be as identified in the appropriate database/settings tables and sequences of operation shown in the drawings. The number of and location of Smart Field Panels shown on drawings shall be provided as a minimum. Computing devices, as defined in 47 CFR 15, supplied as part of the UMCS shall be certified to comply with the requirements of Class B computing devices, while Smart Field Panels, Unitary Controllers, and Universal Programmable Controllers shall as a minimum meet the requirements of Class A computing devices, and shall be labeled as set forth in 47 CFR 15. The workstation shall communicate with FEPs using Data Transmission System

(DTS) and equipment as shown and specified in Paragraph DATA TRANSMISSION SYSTEMS. The Main Control Room Field Panel may also serve as the workstation if all interface components are provided. Every connected analog output (AO), analog input (AI), digital output (DO), digital input (DI), pulse accumulator (PA) input and other input or output device connected to the UMCS shall represent a "point" where referred to in this specification. The Contractor shall provide hardware configured and sized to support specified functions, including expansion, as specified and shown. The existing control systems shall remain in operation until the new UMCS is ready for cutover.

1.2.2 System Overall Reliability

The system shall be configured and installed to yield a mean time between failure of at least 5000 hours, calculated based on the configuration specified in paragraph RELIABILITY CALCULATION. Each UMCS FEP shall be designed, configured, installed and programmed to provide for independent stand-alone operation with minimal performance degradation upon failure of other system components to which it is connected or with which it communicates.

1.2.3 Symbols, Definitions, and Abbreviations

Symbols, definitions, and engineering unit abbreviations utilized in information displays and printouts shall conform to IEEE Std 100 and ASHRAE Hdbk-IP, as applicable.

1.2.4 System Accuracy and Display

The system shall maintain the specified end-to-end accuracy from sensor to all workstation displays, including the effects of transmitters, transducers, and engineering units conversions, for one year for the applications specified and shall report and display changes in sensed values as specified. The system accuracy and display requirements are as follows:

1.2.4.1 Space Temperature

Space temperature with a range of plus 30 to plus 130 degrees F plus or minus 1.0 degrees F, (display and print to nearest 0.1 degree F).

1.2.4.2 Outside Air (OA) Temperature

Outside air temperature with a range of minus 20 to plus 120 degrees F plus or minus 1.0 degrees F.

1.2.4.3 Water Temperature

Water temperature with a range of plus 30 to plus 100 degrees F, plus or minus 0.75 degrees F (display and print to nearest 0.1 degrees F).

1.2.4.4 Relative Humidity

The r.h. with a range of 20 to 80% for indoor applications, plus or minus 3%.

1.2.4.5 Pressure

Pressure in pounds per square inch with a range for the specific

application, plus or minus 2.0% of range (display and print to nearest pounds).

1.2.4.6 Level

Level with a range for the specific application, plus or minus 1.0% of range (display and print to nearest unit).

1.2.4.7 Electrical Measurements

Electrical measurements with a range for the specific application plus or minus 1.0% of range (display and print to nearest 0.1 for volts and amperes, and to the nearest 0.01 for var and PF).

1.2.4.8 Miscellaneous Measurements

Miscellaneous measurements with a range for the specific application plus or minus 1.0% of range (display and print to nearest 0.1 of the specified units)

1.2.4.9 Analog Value Input

An analog value input to the system's equipment via an AI with a maximum error of 0.50% of range, not including the sensor or transmitter error. This accuracy is required over the specified environmental conditions.

1.2.5 Process Loop Accuracies

The system shall maintain the specified process control loop accuracies, including the effects of sensors, control devices, engineering units conversions, algorithms, and equipment controlled for one year for the control loops shown. The accuracy requirements, unless otherwise shown in individual system sequences of operation, are:

1.2.5.1 Temperature

Space and duct temperatures shall be controlled within plus or minus 1 degrees F.

1.2.5.2 Humidity

Space humidity shall be controlled within plus or minus 5% of setpoint.

1.2.5.3 Pressure

Duct supply static pressures and liquid supply pressures shall be controlled to within plus or minus 5% of required design pressures.

1.3 ENVIRONMENTAL CONDITIONS

1.3.1 Field Equipment

The Smart Field Panels, Unitary Controllers, Universal Programmable Controllers, Input/Output (I/O) functions, and other field equipment shall be rated for continuous operation under ambient environmental conditions of 35 to 120 degrees F dry bulb and 20 to 90% r.h., condensing. Instrumentation and control elements shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the

installed location. Where installed outdoors, sensors shall be capable of operating between minus 30 and 122 degrees F without suffering damage or affecting their calibration.

1.3.2 Work Station Equipment

Work Station Equipment, unless designated otherwise, shall be rated for continuous operation under ambient environmental conditions of 60 to 85 degrees F and r.h. of 20 to 80%, noncondensing.

1.3.3 Surge Protection

UMCS components shall be protected from the effects of surges as follows:

1.3.3.1 Power Line Surge Protection

Equipment connected to ac circuits shall be protected from power line surges. Equipment protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

1.3.3.2 Sensor and Control Wiring Surge Protection

I/O functions as specified shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

- a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
- b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Fuses shall not be used for surge protection.

1.3.3.3 Communications Circuits Surge Protection

Communication equipment shall be protected against surges induced on its communications circuits. Metallic cables and conductors which serve as communications circuits from Work Station to Smart Field Panels, and between Smart Field Panels, Unitary Controllers, Universal Programmable Controllers, or other field hardware shall have surge protection installed at each end. Protection shall be furnished at equipment and additional triple electrode gas surge protectors rated for the application on each communications circuit shall be installed within one meter of the building cable entrance. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

- a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

1.3.3.4 Network Surge Protection

Network surge protectors with male-female connectors shall be supplied and installed between the I/O port and the T-connector for every device connected to the LAN. Surge protector characteristics shall be as follows:

- a. Response Time: 10 nanoseconds maximum.
- b. Clamp Voltage: 9 Vac.

- c. Energy Handling: 50 joules minimum.
- d. Capacitance: 8 pF maximum.

1.3.4 Power Line Conditioner

A Power Line Conditioner shall be furnished for each Smart Field Panel. It shall provide both voltage regulation and noise rejection and shall be of ferro-resonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side. The units shall be sized for 125% of the actual connected kVA load. Characteristics shall be as follows:

- a. At 85% load, the output voltage shall not deviate by more than plus or minus 3% of nominal when the input voltage fluctuates between minus 15% to plus 10% of nominal.
- b. During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus 3% of nominal. Full correction of load switching disturbances shall be accomplished within one cycle.
- c. Total harmonic distortion shall not exceed 5% at full load.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G

Detailed shop drawings, containing no proprietary data, shall be submitted in accordance with the CONTRACT CLAUSES, and other sections of the contract. Shop drawings shall include, as appropriate: product specific catalog cuts; a drawing index; a list of symbols; a series of drawings for each control system using abbreviations, symbols, nomenclature and identifiers as shown; and damper schedules.

SD-03 Product Data

Manufacturer's Catalog Data; G

Product specific catalog cuts shall be in booklet form, indexed to the unique identifiers, and shall consist of data sheets that document compliance with the specification. Where multiple components are shown on a catalog cut, the application specific component shall be marked.

Delivery of Technical Data and Computer Software; G

Computer software and related technical data, 30 days after Notice to Proceed.

Dampers; G

The damper schedule shall contain a unique identifier corresponding to and in sequence with the existing identification scheme, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, positive positioner ranges, locations of actuators and damper end switches, and methods of connecting dampers, actuators, and linkages for each damper and actuator furnished. The damper schedule shall include the maximum expected velocity through the damper at the intended location and the maximum leakage rate at the operating static pressure differential. The damper schedule shall contain actuator selection data supported by calculations of the torque required to move and seal the dampers, and shall show access and clearance requirements.

1.5 DELIVERY OF TECHNICAL DATA AND COMPUTER SOFTWARE

Technical data and computer software (meaning technical data which relates to computer software) which is specifically identified in this project, and which may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. Final manuals and drawings shall be provided on hard copy as specified and on CD ROM. System and installation drawings shall be delivered in Intergraph Microstation format (DGN). Data to be submitted shall be organized as follows:

1.5.1 Group I Technical Data Package

The Group I Technical Data Package shall include complete system, equipment, and software descriptions, with calculations used in sizing equipment required by this project. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

a. Equipment Data:

- (1) UMCS block diagram.
- (2) DTS layout, equipment, and functional description.
- (3) Communication network description.
- (4) Communication speeds.
- (5) Smart Field Panel/Unitary Controller/Universal Programmable Controller installation and block diagrams.
- (6) Smart Field Panel/Unitary Controller/Universal Programmable Controller I/O function capacity, including specified spare capacity.
- (7) Smart Field Panel/Unitary Controller/Universal Programmable Controller memory size, type, and configuration.
- (8) Smart Field Panel/Unitary Controller/Universal Programmable

Controller physical layout.

- (9) Details of connections to power sources, including grounding.
- (10) Details of surge protection device installation.
- (11) Sample of instrumentation and control wiring and installation drawings, showing wire routing on floor plans including terminal numbers, wire colors/numbers, and cable designations.
- (12) Work Station equipment installation and block diagrams.
- (13) Command response time calculations.
- (14) Alarm response time calculations for analog and digital alarms.
- (15) System expansion capability and method of implementation.

b. Software Data:

- (1) Smart Field Panel/Unitary Controller/Universal Programmable Controller operation, all modes specified.
- (2) Work Station equipment operation.
- (3) Workstation operations.
- (4) Database update procedures and response time calculations, not including latency time required by the LAN.
- (5) Sample copy of each report specified.
- (6) Color photographs or color graphic print representative of typical graphics.
- (7) Library of graphics symbols.
- (8) Library of application software.
- (9) Data entry forms.
- (10) Object Oriented Programming data and instructions.

- c. System Overall Reliability Calculations: The data package shall include manufacturer's reliability data and calculations required to show compliance with the specified reliability in accordance with paragraph RELIABILITY CALCULATION.
- d. Certifications: All certifications shall be delivered as specified.
- e. Installation Procedures and Requirements: Provide all information needed for interface of chiller panels and boiler panels with the UMCS.

1.5.2 Group III Technical Data Package

The Contractor shall prepare test procedures for the factory test using MIL-STD-2202 as a technical and format requirement. The test procedures shall cover actual equipment and sequences to be utilized by the Contractor for the specific project and shall describe all tests to be performed, and other pertinent information such as specialized test equipment required, length of factory test, and location of the factory test. The procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with all requirements of this specification, and the methods for simulating the necessary conditions of operation to demonstrate performance of the system. The factory test procedures shall demonstrate the capability of the system to monitor and control equipment and to accomplish the control and monitoring shown and as required by the sequences of operation.

1.5.3 Group IV Technical Data Package

The Group IV Technical Data Package shall include the following:

- a. Operation and Maintenance Manuals: A draft copy of the operation and maintenance manuals, as specified for the Group V technical data package, shall be included with the PVT procedures for use during procedure review and site testing.
- b. Training Documentation: Lesson plans/training manuals for the training phases, and including a listing of reference materials.
- c. Data Entry Forms: Completed data entry forms documenting data from the contract documents, Contractor's field surveys, and other pertinent information in the Contractor's possession required for complete installation of the database. The Contractor shall identify, and request from the Government, additional data needed to provide a complete and operational UMCS. The completed forms shall be delivered to the Government for review and incorporation of any additional information needed.
- d. Drawings: Sample of typical instrumentation and control wiring and installation drawings, showing wire routing on floor plans including terminal numbers, wire colors/numbers, and cable designations.

1.5.4 Group V Technical Data Package

The Group V Technical Data Package shall consist of the operation and maintenance manuals. Final copies of the manuals, bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representatives for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include modifications made during installation, checkout, and acceptance. The manuals include:

- a. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and other requirements shall be included for each system operating mode.
- b. Hardware Manual: The hardware manual shall provide detailed data describing equipment furnished, including:
 - (1) General description and specifications.
 - (2) Installation and checkout procedures.
 - (3) Equipment electrical schematics and layout drawings.
 - (4) System schematics and I/O wiring lists.
 - (5) Alignment and calibration procedures.
 - (6) Manufacturer's repair parts list indicating sources of supply.
 - (7) Interface definition.
 - (8) DTS.
- c. Software Manual: The software manual shall describe software functions, and shall include other information necessary to enable proper loading, testing, and operation. The manual shall describe and document software provided as part of the UMCS. Where the supplier's standard software packages are utilized, the software manual shall include complete user documentation.
 - (1) The software manual shall have a separate section for Work Station and Work Station software including:
 - (a) Definitions of terms and functions.
 - (b) Procedures for system startup.
 - (c) Description of the application programs.
 - (d) Description of required sequences using control sequence software.
 - (e) Database format and data entry requirements.
 - (f) Directory of disk files.
 - (g) Parameter schedules.
 - (h) Operator commands.
 - (i) Report generator data format, output format, and content.
 - (j) Alarm messages and format.
 - (k) System access requirements.
 - (l) Description of communications protocols, including data formats,

command characters, and a sample of each type of data transfer.

- (m) Description of graphical object oriented programming.
 - (2) The software manual shall have a separate section for Smart Field Panel, Unitary Controller, and Universal Programmable Controller software, including:
 - (a) Definitions of terms and functions.
 - (b) Descriptions of the applications.
 - (c) Description of required sequences using control sequence software.
 - (d) Database format and data entry requirements.
 - (e) Alarm messages and format.
 - (f) System access requirements.
 - (g) Description of communications protocols, including data formats, command characters, and a sample of each type of data transfer.
- d. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for equipment including inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.
- e. Operator's Manual: The operator's manual shall fully explain procedures and instructions for operation of the system, including:
 - (1) Workstations.
 - (2) LAN/WAN/DTS.
 - (3) System startup and shutdown procedures.
 - (4) Alarm presentation.
 - (5) Recovery and restart procedures.
 - (6) Data entry.
 - (7) Parameter schedules.
 - (8) Operator commands.
 - (9) Use of report generator.
 - (10) Report generator data format, output format, and content.
 - (11) Alarm messages and format.
 - (12) System access requirements.
 - (13) Graphics.
- f. Operator's Condensed Manual: The operator's condensed manual shall contain complete outline instructions, guidance, and

reference data sufficient to allow a trained operator to use the FEP portable tester/workstation specified. The manual shall be presented in a compact booklet form.

- g. Installed Software Documentation: The installed software manual shall include original and backup copies of the run-time version of all object modules delivered for this project, on each type of media utilized, including CD ROM. In addition, a copy of individual floppy disks of software for each FEP shall be furnished.

1.5.5 Group VI Technical Data Package

The Group VI Technical Data Package shall consist of the updated as-built drawings revised to include system revisions and modifications. Copies of the updated as-built drawings shall be delivered to the Government after opposite season test and prior to final acceptance.

1.6 TESTING

The Contractor shall perform factory testing of the UMCS as specified. The Contractor is responsible for providing personnel, equipment, instrumentation, and supplies necessary to perform required testing. Written notification of planned testing shall be given to the Government at least 21 days prior to testing, and in no case shall notice be given until after the Contractor has received written Government approval of the specific test procedures. The test procedures shall define the tests required to ensure that the system meets technical, operational, and performance specifications. The test procedures shall define location of tests, milestones for the tests, and identify simulation programs, equipment, personnel, facilities, and supplies required. The test procedures shall provide for testing all capabilities and functions specified and shown. The test procedures shall be developed from the design documentation, using the requirements of MIL-STD-2202 and MIL-STD-2203 as a technical and format requirement. The procedures shall cover actual equipment and sequences to be used by the Contractor for the specified project and shall consist of detailed instructions for test setup, execution, and evaluation of test results. The test reports shall be used to document results of the tests. Reports shall be delivered to the Government within 7 days after completion of each test.

1.7 TRAINING

The Contractor shall conduct training courses for designated personnel in the maintenance, service, and operation of the system as specified, including specified hardware and software. The training shall be oriented to the specific system provided under this contract. Training manuals shall be delivered for each trainee with two additional copies delivered for archival at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The Contractor is responsible for furnishing audiovisual equipment and other training material and supplies. Where the Contractor presents portions of the course material by audiovisuals, copies of those audiovisuals shall be delivered to the Government as a part of the printed training manuals. When training is conducted at Government facilities, the Government reserves the right to videotape the training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For

guidance in planning the required instruction, the Contractor should assume that attendees will be tradesmen such as electricians or boiler operators. Approval of the Contractor's training schedule shall be obtained from the Government at least 30 days prior to the training.

1.7.1 Operator's Training

The first course shall be taught at the project site for a period of 2 consecutive training days. A maximum of 6 personnel will attend this course. Upon completion of this course, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include:

- a. General system architecture.
- b. Functional operation of the system, including workstations.
- c. Operator commands.
- d. Application programs, control sequences, and control loops.
- e. Color graphics generation.
- f. Database entry and modification.
- g. Reports generation.
- h. Alarm reporting.
- i. Diagnostics.
- j. Historical files.
- k. LAN administration.
- l. Graphical object oriented programming language.

1.7.2 Maintenance Training

The maintenance course shall be taught at the project site after completion of the Endurance Test for a minimum period of 3 training days. A maximum of 10 personnel will attend the course. This training shall not be scheduled at the same time as any session of operator training. The training shall include:

- a. Physical layout of each piece of hardware.
- b. Troubleshooting and diagnostic procedures.
- c. Repair instructions.
- d. Preventive maintenance procedures and schedules.
- e. Calibration procedures.

1.7.3 Specialized Maintenance

Training Immediately following the maintenance training a minimum of one

day of training shall be provided by a factory representative or a qualified Contractor trainer for each of the following:

- a. Each type of meter, to include maintenance, testing and calibration flow elements and transducers. Training shall be provided for 6 people.

1.8 MAINTENANCE AND SERVICE

The Contractor shall provide inspections and associated preventative maintenance, repair, and normal and emergency service calls, for the system including DTS. The Contractor shall furnish labor, supervision, tools, materials, equipment, transportation, and management necessary to provide maintenance, service and repair for the UMCS in accordance with the requirements as specified. The Contractor shall also maintain and repair devices connected to and used by the UMCS in accomplishing its control and monitoring functions. This work includes inspection, testing, cleaning, lubrication, adjustment, calibration, and part or component replacement as specified. Work includes providing necessary preventive and unscheduled maintenance and repairs to keep the UMCS operating as specified, and accepted by the Government, and other services as specified. Work shall meet the specified standard and comply with manufacturer's recommendations and industry standards. The Contractor shall provide technical support via telephone during Contractor's regular working hours.

1.8.1 Work Coordination

The Contractor shall schedule and arrange work to cause the least interference with the normal Government business and mission. In those cases where some interference may be essentially unavoidable, the Contractor shall coordinate with the Government to minimize the impact of the interference, inconvenience, equipment downtime, interrupted service and personnel discomfort.

1.8.2 Work Control

- a. The Contractor shall implement work control procedures to ensure timely accomplishment of work requirements, as well as to permit tracking of work in progress. The Contractor shall plan and schedule work to ensure material, labor, and equipment are available to complete work requirements within the specified time limits and in conformance with the specifications. Verbal scheduling and status reports shall be provided when requested by the Government. Work shall meet the specified standards, and comply with manufacturer's recommendations and industry standards. The Contractor shall comply with user, local, state and federal standards and applicable building and safety codes.
- b. When the Contractor completes work on a system or piece of equipment, that system or piece of equipment shall be free of missing components or defects which would prevent it from functioning as originally intended and designed. Corrective or repair/replacement work shall be completed, including operational checks and cleanup of the job site. Except where otherwise noted, replacements shall conform to the specification. During and at completion of work, debris shall not be allowed to spread unnecessarily into adjacent areas nor accumulate in the work area itself. Such debris, excess material, and parts shall be cleaned up and removed at the completion of the job and/or at the end of

each day that work is in progress.

1.8.3 Working Hours

Working hours are from 7:30 A.M. to 4:00 P.M. Mondays through Fridays except legal holidays.

1.8.4 Equipment Repairs

Equipment repairs shall be initiated within 24 hours of first notification, and repairs shall be completed within 48 hours. Repair is the restoration of a piece of equipment, a system, or a facility to such condition that it may be effectively utilized for its designated purposes. Repair may be overhaul, reprocessing, or replacement of nonfunctional parts or materials that have failed or deteriorated by action of the elements or usage and have not been corrected through maintenance, or replacement of the entire unit or system if beyond economical repair.

1.8.5 Replacement, Modernization, Renovation

The Government may replace, renovate, or install new equipment at Government expense and by means not associated with this contract. Replaced, improved, updated, modernized, or renovated systems and equipment interfaced to the system may be added to the Contractor's maintenance and service effort.

1.8.6 Access To UMCS Equipment

Access by the Contractor shall be in accordance with the following:

- a. The Contractor shall be responsible for obtaining access to facilities and arrange that they be opened and closed during and after the accomplishment of the work effort. The Contractor should allow approximately 15 minutes delay time per access to each security controlled facility. For Contractor access to a controlled facility during other than regular working hours, the Contractor shall contact the Government for assistance. Service calls must still be completed within the time limits specified unless the cause of the problem is determined to be in UMCS equipment located within the controlled facility which required a delay to obtain entry, in which case the required response time will be extended by the amount of time access to the controlled facility was denied.
- b. The Government will provide keys for access to UMCS equipment where the Government determines such key issuance is appropriate. The Government has no obligation to provide such keys.
- c. The Contractor shall establish and implement methods of ensuring that keys issued to the Contractor by the Government are not lost or misplaced, are not used by unauthorized persons and are not duplicated. The Contractor shall develop procedures covering key control that shall be included in the quality control plan.

1.8.7 Preventive Maintenance Work Plan

The Contractor shall strictly adhere to the approved work plan to facilitate Government verification of work. If the Contractor finds it

necessary to reschedule maintenance, a written request shall be made to the Government detailing the reasons for the proposed change at least five days prior to the originally scheduled date. Scheduled dates shall be changed only with the prior written approval of the Government.

1.8.8 Records, Logs, and Progress Reports

The Contractor shall keep records and logs of each task, and shall organize cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for system devices on a building by building basis. The log shall contain digital points and initial analog span and zero calibration values. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the UMCS.

1.8.8.1 Service Call Reporting Requirements

The Contractor shall complete a service call work authorization form for each service call by close of business on the day when the service is completed.

1.8.8.2 Progress Reporting Requirements

The Contractor's progress reports shall include:

- a. Service call authorization and completion forms (Emergency Service Call) to be delivered daily.
- b. Service call authorization and completion forms (Normal Service and Emergency Service Call) to be delivered weekly.
- c. Field equipment calibration records to be delivered weekly.
- d. Telephone consultation log to be delivered monthly.
- e. Maintenance inspection records to be delivered semiannually.
- f. Historic files to be delivered semiannually.

1.8.9 Maintenance Requirements

During the first year of acceptance, the Contractor shall perform monthly, semiannual, and annual maintenance procedures or as described below, or more often if required by the equipment manufacturer.

1.8.9.1 Semiannual Maintenance

- a. Clean Work Station Equipment, FEPs and interface panels including interior and exterior surfaces.
- b. Run system diagnostics and correct diagnosed problems.
- c. Fan checks and filter changes for UMCS hardware.
- d. Mechanical adjustments, new ribbons, new cartridges for laser printers and other necessary adjustments on printers.
- e. Check and calibrate each field device; then compare its calibrated

value against its reading at the Operator's Workstation. Check and calibrate 50% of the total analog points during the first semiannual inspection. Check and calibrate the remaining 50% of the analog points during the second semiannual inspection. Certify analog test instrumentation accuracy to be twice that of the device being calibrated. Check 50% of digital points for proper operation during the first semiannual inspection. Check the remaining 50% of digital points during the second semiannual inspection.

- f. Resolve all outstanding problems.

1.8.9.2 Annual Maintenance

Includes all items in semiannual maintenance, plus any other maintenance requirements in addition to those covered in the semiannual maintenance requirements.

1.8.9.3 Maintenance Procedures

- a. I/O Functions: I/O function calibration checks shall include before and after calibration readings (deviation of reading from actual value as measured by a known calibration standard). Contractor shall utilize analog test instrument with calibration traceable to the National Institute of Standards and Technology, and shall provide calibration documentation at the request of the Government. Analog test instrumentation shall be at least twice as accurate as the device being calibrated. Calibrations shall be within the tolerances of the original equipment. The Contractor shall adjust devices not conforming to the required accuracies, except those which are factory set and sealed. These factory sealed devices shall be replaced (not adjusted). The Contractor shall take UMCS equipment off-line for calibration in accordance with manufacturers' requirements; no equipment malfunctions or erroneous alarms shall occur due to Contractor calibration actions. Equipment that cannot be calibrated shall be replaced at no cost to the Government. For each analog and digital point being controlled by the UMCS, the Contractor shall command each point and verify its proper operation, and the proper operation of connected equipment such as fans, valves, and dampers. Where practicable, create the field conditions for change of state DIs and verify proper reporting at the Operator's Workstation.
- b. FEPs: FEP maintenance shall include condition of paint, cabinet door seals, cabinet door locks, terminal strip connections, circuit card cage, circuit cards, power supplies, connectors, interconnecting cables and electrical connections, and power line conditioner. Maintenance of the FEP's heaters, CPU, memory, input/output functions and software shall also be included. In addition, voltage measurements shall be made and required adjustments made to bring the voltage levels to within manufacturers' tolerances; verification of proper operation of indicating lamps and switches shall be made; verification that equipment cabinet is at earth ground potential shall be made; and transient and lightning protection shall be inspected for signs of damage.
- c. Workstations: Workstation maintenance shall require the Contractor to request Government approval prior to beginning

required maintenance, 14 calendar days prior to the required start of maintenance. The system components will not be permitted to be off-line for more than 16 hours total for each scheduled maintenance. The Contractor shall run utilities to verify the structure and consistency of the hard disk file systems, performed on each disk. The Contractor shall perform a complete backup of the system prior to running diagnostics; this backup will be performed with the system online.

- d. Printer: Printer maintenance shall include required lubrication and cleaning of the printing mechanism and the cleaning of the case and keyboard, replacement of the ribbon or printing cartridge, complete testing and documentation. All work and material which is necessary shall be provided.
- e. Software/Firmware: Software/firmware maintenance includes operating systems, application programs, and files required for the proper operation of the UMCS whether resident on disk, in Random Access Memory (RAM), in all types of Programmable Read Only Memory (PROM), or in Read Only Memory (ROM). User-developed software is not covered by this contract, except that the UMCS software/firmware must be maintained to allow user creation, modification, deletion, and proper execution of such user-developed software as specified. Software/firmware must be maintained to fully perform functions as specified in the manufacturer's documentation. The Contractor shall perform diagnostics and corrective reprogramming as required to maintain total UMCS operations as specified. The Contractor shall back up software before performing any computer hardware and software maintenance. In order to maintain the software/firmware in accordance with the requirements of this contract, the Contractor may provide and install software/firmware updates at the Contractor's expense upon obtaining written approval from the Contracting Officer. Software/firmware updates and other modifications shall not degrade the performance or decrease the functionality of any part of the UMCS, and shall be provided with the same Rights in Technical Data and Computer Software as the original software/firmware. Documentation and magnetic media shall be modified to reflect the updates and modifications. The Contractor shall not modify any database parameters without approval from the Government. Any approved changes and additions to the database shall be properly documented, and the appropriate manuals shall be updated.
- f. DTS: DTS maintenance shall include testing transmission media and equipment to verify signal levels, system data rates, errors and overall system performance.

1.8.10 Service Call Reception

- a. The Contractor shall have procedures for receiving and responding to service calls 24 hours per day, seven days a week, including weekends and holidays. A single telephone number shall be provided by the Contractor for receipt of service calls during regular working hours. For service calls after regular working hours, the Contractor may provide a calling list of no more than three telephone numbers; the Contractor may alternatively provide a pager telephone number. Telephone calls shall be answered within 30 seconds, or pager calls returned within 10 minutes, by

an individual fully familiar with the maintenance and service procedures. Service calls shall be considered received by the Contractor at the time and date the telephone call is placed by the authorized Government representative.

- b. The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. The Contractor shall complete a service call work authorization form for each service call.
- c. The Contractor shall respond to each service call request within two (2) working hours. The status of any item of work must be provided within 4 hours of the inquiry during regular working hours, and within 16 hours after regular working hours. Response time is defined as the time allowed the Contractor after initial notification of a work requirement to be physically on the premises at the work site with appropriate tools, equipment, and materials, ready to perform the work required.
- d. A Government representative will advise the Contractor by phone or in person of all maintenance and service requests, as well as the classification of each based on the definitions specified. A description of the problem or requested work, date and time notified, location, classification, and other appropriate information will be placed on a Service Call Work Authorization Form by the Government and made available for pickup by the Contractor, or sent via fax to the Contractor by 12 noon the following Government workday.

1.8.11 Service Call Work Warranty

The Contractor shall provide a 90 day unconditional warranty on service call work. The warranty shall include labor and material necessary to restore the equipment involved in the initial service call to a fully operable condition. In the event of failure of Contractor service call work that causes damage to additional equipment in the system the Contractor is liable for labor and material to restore that equipment to full operation. Contractor response to service call warranty work shall be the same as required by the initial service call.

1.8.12 System Modifications

The Contractor shall make recommendations for system modification in writing to the Government. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Government. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected. The Contractor shall make available to the Government operating and application software updates during the life of this contract. The Government will notify the Contractor if the updates can be installed. Maintenance releases of the UMCS system software shall be provided at no additional cost to the Government. These updates shall be accomplished in a timely manner, fully coordinated with UMCS operators, and shall be incorporated into the operations and maintenance manuals, and software

documentation. There shall be at least one scheduled update near the end of the contract period, at which time the Contractor shall make available the latest released version of the Contractor's software, and shall install and validate it upon approval by the Government.

1.8.13 Telephone Consultation and Remote Software Service

The Contractor shall provide up to 48 hours per year of telephone consultation to Government personnel. The Government will initiate telephone consultation calls during regular working hours for the purposes of identifying and resolving apparent operational problems with the UMCS. The Contractor shall provide personnel fully familiar with the subject matter of the Government initiated call. Approximately 60% of telephone consultation will require a skill level equivalent to a system analyst, and approximately 40 % of the telephone consultation will require a skill level equivalent to a computer programmer. The Contractor shall keep a log of the dates, times, names of Government personnel, and duration of each call, and shall advise the designated Government personnel when more than 4 hours of consultation time has been expended in any month. The Contractor shall not provide over 4 hours of consultation per month without authorization from the Government. The Contractor shall submit a copy of the log to the Government each month.

1.8.14 System Manager

The Contractor shall provide a system manager on exclusive assignment for the UMCS during normal first shift working hours to interface with Government personnel and Contractor personnel. The system manager shall not be involved with field work such as field calibration of sensors, field service calls, and field maintenance of equipment, but shall manage this work from Work Station. The system manager shall perform general tasks such as preparation of custom programs and reports, installation of software, backups, preparation of custom graphics and updates of the point database. The system manager shall be responsible for checking the UMCS daily, including weekends and holidays, by logging into the system at a minimum of twice each day, once in the morning and once in the evening. The system check shall include monitoring alarms and system failures. The system manager's response to these alarms and system failures shall be to immediately contact Government personnel for further instructions. Specific procedures and phone listings of assigned Government personnel will be furnished to the Contractor after award.

1.9 DATA TRANSMISSION SYSTEMS (DTS)

Data Transmission Systems shall be provided in Section 16792 and as shown.

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

2.1.1 Materials and Equipment

Units of the same type of equipment shall be products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment shall be standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products. Items of the same type and purpose shall be identical and supplied by the same manufacturer, unless replaced by a new version

approved by the Government.

2.1.2 Enclosures

Electrical and electronic devices not located within an FEP shall be mounted in an enclosure unless otherwise specified or shown. Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures for installation in clean, dry indoor occupied space (the Main Control Room only) may be Type 1; all other locations shall be Type 4X or as shown, and shall contain a thermostatically controlled space heater to maintain the enclosure above the dew point if required by the equipment installed.

2.1.3 Analog Standard Signals

The output of analog transmitters and the analog input and output of FEPs shall be 4-to-20 mA dc signals, except for air distribution terminal unit control equipment. The signal shall originate from current sourcing devices and shall be received by current sinking devices.

2.1.4 Key Operated Switches

Hand-Off-Automatic (HOA), off-automatic, three-way momentary contact on-off, and similar use switches shall be key operated with switches keyed alike, or such switches shall be protected by a key locked enclosure (except where shown as non-key operated). Switches shall be rated for a minimum of 600 Vac, 5A, and shall be mounted in an enclosure as specified or shown. Dual auxiliary contacts shall be provided for the automatic position to provide position sensing at the FEP. Auxiliary contacts shall be rated at least 120 Vac, 1 A.

2.1.5 Nameplates

Laminated plastic nameplates shall be provided for equipment devices and panels furnished. Each nameplate shall identify the function, such as "override switch for circuit xxx " or "Pressurization control panel xxx." Laminated plastic shall be 1/8 inch thick, white with black center core. Nameplates shall be a minimum of 1 x 3 inches with minimum 1/4 inch high engraved block lettering. Nameplates for devices smaller than 1 x 3 inches shall be attached by a nonferrous metal chain. All other nameplates shall be attached to the device.

2.2 ACTUATORS

Actuators shall be electric or electronic as shown. Actuators shall fail to their spring return-positions as shown on signal or power failure and shall have a visible position indicator. Actuators shall open or close the devices to which they are applied within 30 seconds after a full scale input signal change. Electric or electronic actuators operating in parallel or in sequence shall have an auxiliary actuator driver. Modulating actuators in control sequences involving two or more devices operating in sequence, sequencing two or more stages, increments, or steps of capacity, or when actuators are operating at 75% or more of rated capacity, or wherever accurate positioning is required to achieve the specified control sequences, shall be provided with positive positioners. Actuators shall smoothly operate the devices to which they are applied. Actuators shall fully open and close the devices to which they are applied

and shall have a full stroke response time of 60 seconds or less. The actuator stroke shall be limited by an adjustable stop in the direction of power stroke.

2.2.1 Electric Operators

The Contractor shall provide gear type electric operators. Each operator shall deliver the torque required for continuous uniform movement of the valve or damper and shall have an end switch to limit travel or shall withstand, without damage, continuous stalling. Operators shall function properly with a range of 85 to 110% of rated line voltage. Drive train gears shall be steel or copper alloy. Shafts shall be hardened steel running in sleeve bearings of copper alloy, hardened steel, nylon, or ball bearings. Operators and gear trains shall be totally enclosed in dust proof housings with rigid conduit connections. Gear trains shall be oil immersed or permanently lubricated. Two-position operators shall be of the single direction, spring return, or reversing type. Proportioning operators shall be capable of stopping at any point in the cycle and starting in either direction, from any point. Reversing and proportioning operators shall have limit switches to limit travel in either direction, unless the operator is a stall type. Valve operators shall be equipped with a spring yield device so that when in a relaxed position, the device shall maintain a pressure on the valve disc equivalent to the system pressure at the valve. Failure mode operation shall include the accessories required to hold the controlled device in the desired failure mode position.

2.2.2 Damper Actuators

Damper actuators shall be rated for at least 125% of the maximum motive power necessary to operate against the pressure shown. The actuator stroke shall be limited by an integral adjustable stop in the direction of power stroke. The actuators shall be provided with mounting and connecting hardware arranged for placing the actuator parallel to the plane of the damper.

2.2.3 Valve Actuators

Valve actuators shall be rated for at least 125% of the motive power necessary to operate the valves over their full range of operation against the total and differential pressures shown.

2.3 DAMPERS

2.3.1 Damper Assembly

2.3.1.1 Damper Blades

A single damper section shall have blades no longer than 48 inches and shall be no higher than 72 inches. Maximum damper blade width shall be 8 inches. Larger sizes shall be made from a combination of sections. Dampers shall be steel, or other materials where shown. Flat blades shall be made rigid by folding the edges. All blade operating linkages shall be within the frame so that blade connecting devices within the same damper section will not be located directly in the air stream. Damper axles shall be a minimum of 1/2 inch plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 0.04 inch water gauge at 1,000 fpm in the wide open position.

Frames shall be at least 2 inches in width. Dampers shall be tested in accordance with AMCA 500-D.

2.3.1.2 Damper Links

Operating links external to dampers (such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers) shall withstand a load equal to at least twice the maximum required damper operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crank arms shall control the open and closed positions of dampers. Damper actuators shall be mounted parallel to the plane of the damper.

2.3.2 Damper Types

Two-position dampers shall be parallel-blade type.

2.3.3 Mechanical and Electrical Space Ventilation Dampers

The dampers may be of the parallel or opposed-blade type. Dampers shall not leak in excess of 80 cfm per square foot at 4 inches water gauge static pressure when closed. Dampers shall be rated at not less than 1,500 fpm air velocity.

2.4 INSTRUMENTATION AND CONTROL

2.4.1 Temperature Instruments

2.4.1.1 Resistance Temperature Detector (RTD)

RTD shall be platinum, with an accuracy of plus or minus 0.1% at 32 degrees F. RTD shall be encapsulated in epoxy, Series 300 stainless steel, anodized aluminum, or copper. Each RTD shall be furnished with an RTD transmitter as specified mounted integrally.

2.4.1.2 RTD Transmitter

The RTD transmitter shall be selected to match the resistance range of the RTD. The transmitter shall be a 2 wire device, producing a linear 4 to 20 mA_{dc} output corresponding to the required temperature span. The output error shall not exceed 0.1% of calibrated span.

2.4.1.3 Instrument Shelter

Instrument shelter for outside-air temperature and humidity sensing elements shall prevent the sun from directly striking the sensing elements. The instrument shelter shall be provided with adequate ventilation so that the sensing element responds to the ambient temperature of the surroundings. Instrument shelter shall be fabricated from wood and painted white. Shelter shall have louvered sides, double tops, and slotted bottoms.

2.4.1.4 Sunshield

Sunshield for outside-air temperature sensing elements shall prevent the sun from directly striking the temperature sensing elements. The sunshield shall be provided with adequate ventilation so that the sensing element responds to the ambient temperature of the surroundings. The top of each sunshield shall have a fiberglass rainshield projecting over the face of

the sunshield. The sunshield shall be painted white.

2.4.2 Thermostat

Thermostat ranges shall be selected so that the nominal setpoint is the midpoint of the range.

2.4.2.1 Nonmodulating Room

Thermostat Contacts shall be Form C, wired to identified terminals. The maximum differential shall be 2 degrees F. Thermostat covers shall be made of metal or heavy-duty plastic, and shall be capable of being locked by an allen-head wrench or a special tool. Thermostat shall have manual switches as required by the application.

2.4.3 Relative Humidity Instrument

The r.h. sensors shall use bulk polymer or thin film capacitive type nonsaturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining damage. The sensors shall include removable protective membrane filters. Sensors shall have a range of 20 to 80%, with an accuracy of plus or minus 2% of full scale with a temperature dependence of less than plus or minus 2% from minus 10 to plus 60 degrees C. A transmitter located at the sensor shall be provided to convert the sensor output to a linear 4 to 20 mA_{dc} output corresponding to the required humidity span. The transmitter shall include noninteracting zero and span adjustments. Where required for exterior installation, sensors shall be capable of surviving below freezing temperatures and direct contact with moisture without affecting sensor calibration.

2.4.4 Electrical Instruments

2.4.4.1 Current Sensing Relay for Motors

Current sensing relay shall provide a normally-open contact rated at a minimum of 50 volts peak and 1/2 ampere or 25 VA, noninductive. There shall be a single hole for passage of current carrying conductors. Relay shall be of the split core type, designed for use with existing electrical installations. The devices shall be sized for operation at 50% rated current based on the connected load. Voltage isolation shall be a minimum of 600 volts.

2.4.5 Position Sensor

2.4.5.1 End (Limit) Switch

Limit switch shall be of the enclosed or sealed type as required for the application. Switch contacts shall be Form C snap-action with utilization category and ratings selected for the application.

2.4.5.2 Damper End Switch

Each end switch shall be a hermetically-sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the duct exterior and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade and shall directly sense damper position.

2.4.5.3 Potentiometer

Potentiometer may be either rotary or linear, depending on the application of each position indicator. Position potentiometers shall have a linearity of plus or minus 5% and shall indicate position from 0 to 100% open.

2.4.6 Output Devices

Output device contacts shall be rated for the application. Coils shall be equipped with transient suppression devices to limit transients to 150% of rated coil voltage.

2.4.6.1 Interposing Relay

Interposing relay shall be used to provide remote circuit control of remote equipment, or to provide device status input for those devices which do not have an auxiliary relay contact output available. Relay contacts shall be enclosed in a dust proof enclosure. Relay shall be rated for a minimum of one million mechanical operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Interposing relay shall also meet the following requirements.

Rating: 150 Vac/ 150 Vdc coil, 10 Amperes contacts.

Working Voltage: 120 Vac/ 48 Vdc to 150 Vdc, nominal.

Contact Arrangement: DPDT (2 Form C).

Base: Plug-in socket, suitable for panel mounting.

2.4.6.2 Control Relay

Control relay contacts shall have utilization category and ratings selected for the application, with a minimum of 2 sets of Form C contacts enclosed in a dustproof enclosure. Relay shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less.

2.4.6.3 Time Delay Relay

Time delay relay contacts shall have utilization category and ratings selected for the application with a minimum of 2 sets of Form C contacts enclosed in a dustproof enclosure. Delayed contact opening or closing shall be adjustable from 1 to 60 seconds with a minimum accuracy of plus or minus 2 % of setting.

2.4.6.4 Latching Relay

Latching relay contacts shall have utilization category and ratings selected for the application with a minimum of 2 sets of Form C contacts enclosed in a dustproof enclosure. Relay shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relay operation shall require separate control circuits for switchover from one position to another.

2.4.6.5 Reed Relay

Reed relay shall be encapsulated in a container housed in a plastic, epoxy,

or metal case. Contacts shall have utilization category and ratings selected for the application. Operating and release times shall be 1 millisecond or less. Relay shall be rated for a minimum life of 10 million operations.

2.4.6.6 Contactor

Contactor shall be of the electrically operated, mechanically held type. Contactor operation shall require separate control circuits for switchover from one position to another. Positive locking shall be obtained without the use of hooks, latches, or semipermanent magnets. Contacts shall be double break silver to silver type. Number of contacts, utilization category and ratings shall be selected for the application. Operating and release times shall be 100 milliseconds or less.

2.4.6.7 Solid State Relay

Input-output isolation shall be greater than 1000 megohms with a breakdown voltage of 1500 V rms or greater at 60 Hz. Relays shall be rated for a minimum life of 10 million operations. The ambient temperature range shall be at least minus 20 to plus 140 degrees F. Input impedance shall not be less than 500 ohms. Relay shall have utilization category and ratings selected for the application. Operating and release times shall be 1 millisecond or less.

2.4.6.8 Electric Solenoid Operated Hydraulic (EH) Valve

EH valve shall have four port operation: common, normally open, and normally closed. EH valve shall have an outer cast steel body with internal parts constructed of brass, bronze, or stainless steel. EH valve shall be rated for 2000 psig when used in hydraulic power transfer system operation. EH valve operation shall be rated for a minimum of 150 degrees F.

2.4.7 Miscellaneous Instruments

2.4.7.1 Cable-Extension Position Transducer

Cable-extension position transducer shall be provided with a NEMA 4 or 6 hard-anodized aluminum enclosure. Cable-extension position transducer shall have a full stroke range of 0 to 250 inches. Sensor shall be a plastic-hybrid precision potentiometer. Measuring cables shall be stainless steel. Input voltage shall be 12 to 40 VDC. Input current shall be 20mA, max. Loop resistance shall be 0.02, max. Circuit protection shall be 38 mA maximum. Impedance shall be 100 ohm at 100 VDC, minimum. Electrical output signal shall be 4 mA to 20 mA at full stroke.

2.4.7.2 Directional Speaker Array

Directional speaker array shall consist of an aluminum structure with fiberglass speaker array projectors, stainless steel mounting hardware and one 100 watt driver per speaker. Directional speaker array shall be capable of providing a consistent output of 118 dB at a distance of 100 feet. Directional speaker array shall be capable of providing a steady alert signal. Directional speaker array shall require no maintenance except for periodic speaker tests.

2.4.7.3 Non-Contacting Angular Position Sensor

Non-contacting angular position sensor shall be standard, 360 degree, non-contacting rotary position sensor. Non-contacting angular position sensor shall measure phase shift. Sensor shall self-diagnose open, short circuit and other specific failures. Input signal shall be 100 mA maximum. Sensor output shall be ratiometric. Sensor housing shall be sealed to meet SAE J1455 and shall be able to withstand heavy vibration. Sensor drive shall require very low torque. Provide a compatible I/O connector for interface with the field panel, and PWM outputs signal. Sensor shall be capable of operation within a -40 deg C to 85 deg C temperature range.

2.4.7.4 Exterior Microphone

Exterior Microphone shall be an outdoor heavy-duty omnidirectional type with anti-bird spikes, windscreen and rain cover. The microphone diaphragm and housing shall be constructed of stainless steel. The microphone cartridge shall be 1/2" type with 200V polarization voltage. The microphone shall be flat response with a +/- 20 dB amplifier set by internal jumpers with a frequency response range of 20 Hz - 20 kHz and in compliance with IEC 60651 Type 1 and ANSI S1.4-1983 Type 1. Microphone shall be provided with an internal heating system to prevent condensation. The output amplifier shall be low noise type and designed to drive long cables. Microphone sensitivity shall be adjusted to 50mV/Pa. Dynamic range upper limit shall be 156 dB SPL. Output impedance shall be less than 50 ohms. Output current shall be greater than 25 mA. Power supply shall be 12-18Vdc, 3W. Power consumption shall be 120 mA at 15V supply voltage. Microphone shall be suitable for use within a temperature range of -40 deg C to 50 deg C. Provide non-rusting mounting hardware for a permanent installation.

2.5 WIRE AND CABLE, TRANSFORMERS AND TERMINAL BLOCKS

2.5.1 Wire and Cable

Wire and cable jacket material shall be flame retardant PVC, or fluoropolymer as required for the application per NFPA 70. Multiconductor cable shall have an outer jacket. Wire and cable not indicated as GFE shall be provided.

2.5.1.1 Control Wiring

- a. Digital Functions: Control wiring for digital functions shall be 18 AWG minimum with 600 volt insulation.
- b. Analog Functions: Control wiring for analog functions shall be 18 AWG minimum with 600 volt insulation, twisted and each pair shielded, 2, 3, or 4 wire to match analog function hardware.

2.5.1.2 Sensor Wiring

Sensor wiring shall be 20 AWG minimum twisted and shielded, 2, 3, or 4 wire to match analog function hardware.

2.5.1.3 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for rail mounting, and shall have end plates and partition plates for separation or shall have

enclosed sides.

2.5.2 Transformer

Step-down transformer shall be utilized where control equipment operates at lower than line circuit voltage. Transformer, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Transformer shall be sized so that the connected load is 80% of the rated capacity or less. Transformer shall conform to UL 508 and NEMA ST 1.

2.5.3 Nonconducting Wiring

Duct Nonconducting wiring duct in control panels shall have slotted sides, snap-on duct covers, fittings for connecting ducts, mounting clips for securing ducts, and wire-retaining clips.

2.6 FEP HARDWARE

2.6.1 Smart Field Panel

Smart Field Panels shall be microcomputer-based with sufficient memory provided to perform all specified and shown Smart Field Panel functions and operations, including spare capacity for all spares and its I/O functions specified. All functions, constraints, database information, operator developed programs and any other data shall be downloadable from the work station. Each Smart Field Panel shall have a minimum of 10% of its I/O functions as spare capacity but not less than 2 of each type used in each. The type of spares shall be in the same proportion as the implemented I/O functions on the panel, but in no case shall there be less than two spare points of each type. The panel I/O functions shall be furnished complete, with no changes or additions necessary to support implementation of spare functions. Output relays associated with digital signals shall be considered part of the I/O function, whether physically mounted in the enclosure or separately mounted. Implementation of spare points shall necessitate only providing the additional field sensor or control, field wiring including connection to the system, and point definition assignment by the operator. The panel shall contain all necessary I/O functions to connect to field sensors and control panels. I/O function operation shall be fully supervised to detect I/O function failures. Smart Field Panels shall operate in an independent stand-alone mode, which is defined as all Smart Field Panel operations as specified performed by the Smart Field Panel without any continuing input from the Work Station. All I/O functions of individual monitored and controlled systems shall be implemented in one FEP. The Smart Field Panel shall be capable of controlling a mix of at least 32 Unitary Controllers, and Universal Programmable Controllers.

2.6.1.1 Integral Features

The Smart Field Panel shall include:

- a. Main power switch.
- b. Power on indicator.
- c. Portable Tester/Workstation Connector.
- d. On-Off-Auto switches for each DO.

- e. Minimum-Maximum-Auto switches, or Auto-Manual switches with manual output override, for each AO.
- f. An intrusion detection device, connected as an alarm.

2.6.1.2 Communication Interfaces

Communications interfaces for each DTS circuit between Smart Field Panels and the Work Station and between Smart Field Panels and RTU, Unitary Controllers, and Universal Programmable Controllers, shall be provided. Communication interfaces shall be provided between each Smart Field Panel and all associated I/O functions. The DTS will provide for transmission speeds necessary to comply with performance requirements specified. DTS equipment shall be installed in the Smart Field Panel enclosure.

2.6.1.3 Memory and RTC Backup

The Smart Field Panel memory and real time clock functions shall continue to operate for a minimum of 72 hours in the event of a power failure. If rechargeable batteries are provided, automatic charging of batteries shall be provided and a low battery alarm message shall be sent to the Work Station and a local indication provided.

2.6.1.4 Duplex Outlet

A single phase, 120 Vac electrical service outlet for use with test equipment shall be furnished either inside or within 6 feet of the Smart Field Panel enclosure.

2.6.1.5 Locking Enclosures

Locking type mounting cabinets with common keying shall be furnished for each Smart Field Panel.

2.6.1.6 Failure Mode

Upon failure of the Smart Field Panel, either due to failure of the Smart Field Panel hardware or of the DTS, the Smart Field Panel shall revert to the failure mode as shown.

- a. DTS Failure: Upon failure of communications, the Smart Field Panel shall operate in an independent stand-alone mode. RTUs, Unitary Controllers, and Universal Programmable Controllers connected to the affected Smart Field Panel shall continue to report to the Smart Field Panel.
- b. Smart Field Panel Hardware Failure: Upon failure of the Smart Field Panel hardware, the Smart Field Panel shall cease operation and stop communications with other UMCS components. RTUs, Unitary Controllers and Universal Programmable Controllers connected to the affected Smart Field Panel shall respond to this failure as specified and shown.

2.6.2 Unitary Controller

The Unitary Controller shall be a microprocessor based, stand-alone, dedicated purpose controller, communicating with the Smart Field Panel, designed and programmed to control air distribution system mixing boxes,

terminal units, heat pumps, fan coil units, self-contained DX units or VAV boxes as shown. Each Unitary Controller shall contain resident programs in reprogrammable nonvolatile memory for each specific application implemented. Each Unitary Controller shall contain necessary power supplies, transformers, memory, I/O functions and communications interfaces necessary to perform its required functions and to provide control and monitoring of connected equipment and devices. It shall contain all necessary I/O functions to connect to field sensors and controls. I/O operation shall be fully supervised to detect I/O function failures. It shall provide for operation as a device connected to the system via a Smart Field Panel.

2.6.2.1 Integral Features

The Unitary Controller shall include:

- a. Main power switch.
- b. Communication interface to Smart Field Panel.
- c. All I/O functions required to implement the requirements as shown.
- d. Portable Tester/Workstation Connector.

2.6.2.2 Specific Requirements

Unitary Controller components for dehumidifier units shall be furnished to the unit manufacturer for factory mounting and calibration.

- a. Accessibility and Interfaces: Each Unitary Controller shall be accessible for purposes of application selection, control parameters, setpoint adjustment, and monitoring from the UMCS Workstations and Smart Field Panel as specified and shown. A Portable Tester/Workstation connected to any Smart Field Panel on the network, directly or via modem, shall have the same access. They shall also be accessible with a Communication and Programming Device connected to a communications port on the Unitary Controller.
- b. Unit Controls: Controls shall consist of connections, a room temperature sensor, relative humidity sensor, and an adjustable microprocessor-based controller. The controller shall operate the unit for cooling and heating and provide control outputs for compressor, condenser reheat, and remote condenser. This controller capability shall allow the sequencing all components to maintain conditions in the space.

2.6.2.3 Failure Mode

Upon failure of the Unitary Controller, it shall revert to the failure mode of operation as shown.

2.6.3 I/O Functions

2.6.3.1 FEP I/O Functions

FEP I/O functions shall be defined as functionally part of the Smart Field Panel, RTU, Unitary Controller, or Universal Programmable Controller as specified, and communicate over a dedicated communication circuit. When

remotely located, I/O functions shall be subject to the same requirements as for Smart Field Panel, RTU, Unitary Controller, or Universal Programmable Controller.

2.6.3.2 The AI function

The AI function shall monitor each analog input, perform A-to-D conversion, and hold the digital value in a buffer for interrogation. The A-to-D conversion shall have a minimum resolution of 10 bits. Signal conditioning shall be provided for each AI. All AIs shall be individually calibrated for zero and full scale. The AI shall incorporate common mode noise rejection of 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of 20 dB at 60 Hz from a source impedance of 10,000 ohms. Input signals shall be within the ranges of 0 to 10 Vdc or 4 to 20 mAdc.

2.6.3.3 The AO function

The AO function shall accept digital data, perform D-to-A conversion, and output a signal within the ranges of 0 to 10 Vdc or 4 to 20 mAdc. D-to-A conversion shall have a minimum resolution of 8 bits. All AOs shall be individually calibrated for zero and full scale. Short circuit protection on voltage outputs and open circuit protection on current outputs shall be provided. Contractor shall provide an individual gradual switch for manual override of each AO and means of physically securing access to these switches as specified. Contractor shall provide for each AO a three position switch for selection of the DDC control signal, no control signal, or a locally generated control signal for connection to the controlled device. All switches shall be selected for the application. Switches for pneumatic control outputs shall provide a connection for an externally generated pneumatic signal. All switches shall be either of a key operated design with the same keying system used for other outputs or otherwise suitably protected from unauthorized access by a keyed access.

2.6.3.4 The DI Function

The DI function shall accept on-off, open-close, or other change of state (two state data) indications.

2.6.3.5 The DO function

The DO function shall provide contact closures for momentary and maintained operation of output devices. Closures shall have a minimum duration of 0.1 second. DO relays shall have a breakdown voltage between contacts and coil of at least 500 volt peak. Electromagnetic interference suppression shall be furnished on all output lines to limit transients to nondamaging levels. Minimum contact rating shall be one-half ampere at 24 Vac.

2.6.3.6 The PA Function

The PA function shall have the same characteristic as the DI, except that a buffer shall be provided to totalize pulses and allow for interrogation by the system. The PA shall accept rates up to 10 pulses per second. The accumulator points shall totalize pulses received from dry contacts. A sensing voltage shall be supplied from the FEP. Accumulator points shall accept Form C contacts (both the "Y" and "Z" contacts on kilowatt-hour meter KYZ contacts shall be monitored) and Form "A" or "B" contact inputs. Each PA shall totalize a count of up to 65,536, and shall be able to be read at any time without loss of input data. When each PA reaches its

maximum value, it shall automatically reset to zero, and begin counting pulses again.

2.6.3.7 The Binary Coded Decimal (BCD) Function

The BCD function shall have the same characteristics as the DI, except that, in addition, a buffer shall be provided to totalize inputs and allow for interrogation by the Smart Field Panel. The BCD function shall have 16-channel optically isolated buffered inputs to read four digit numbers. The BCD function shall accumulate inputs at rates up to 10 inputs per second.

2.6.3.8 Failure Mode

Upon failure of the I/O function, including data transmission failure, logic power supply failure, FEP processor malfunction, software failure, interposing relay power failure, or any other failure which prevents stand alone operation of any FEP normally capable of stand alone operation, connected outputs shall be forced to the failure mode shown.

2.6.4 Portable Tester/Workstation

A portable tester/workstation shall be provided and shall be connectable to any FEP. The portable tester/workstation shall consist of a portable computer with a nominal 10 inch active color matrix liquid crystal display, capable of displaying up to 256 colors at a minimum resolution of 640 X 480 pixels, 64 bit microprocessor operating at a minimum of 1.0 GHz. The portable tester/workstation shall have, as a minimum, a 10 GB hard drive, 16 megabytes of memory, integral pointing device, serial and parallel ports, color VGA video port for an external color monitor, switchable C3.5 inch floppy disk drive, modem, PCMCIA Type 3 slot, rechargeable battery, battery charger and 120 Vac power supply. It shall include carrying case, extra battery, charger and a compatible network adapter. The tester/workstation shall:

- a. Run FEP diagnostics.
- b. Load all FEP memory resident programs and information, including parameters and constraints.
- c. Display any AI, DI, or PA input in engineering units.
- d. Control any AO or DO.
- e. Provide an operator interface, contingent on password level, allowing the operator to use full English language words and acronyms, or an object oriented graphical user interface.
- f. Display database parameters.
- g. Modify database parameters.
- h. Accept FEP software and information via an EIA ANSI/EIA/TIA-232-F port at the Work Station computers provided, for subsequent loading into a specific FEP. Provide all necessary software and hardware required to support this function.
- i. Disable/enable each FEP.

j. Perform all workstation functions as specified.

2.7 FEP SOFTWARE

All FEP software described in this specification shall be furnished as part of the complete UMCS.

2.7.1 Operating System

Each FEP shall contain an operating system that controls and schedules that FEP's activities in real time. The FEP shall maintain a point database in its memory that includes all parameters, constraints, and the latest value or status of all points connected to that FEP. The execution of FEP application programs shall utilize the data in memory resident files. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. Each FEP real time clock shall be automatically synchronized with the system's real time clock at least once per day to plus or minus 10 seconds.

The time synchronization shall be accomplished without operator intervention and without requiring system shutdown. The operating system shall allow local loading of software and data files from the Portable Tester/Workstation. It shall also support data entry and diagnostics using an Operator Interface Panel attached directly to the FEP.

2.7.1.1 Startup

The FEP shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. A FEP restart program based on detection of power failure at the FEP shall be included in the FEP software. Upon restoration of power to the FEP, the program shall restart equipment and restore loads to the state at time of power failure, or to the state as commanded by time programs or other overriding programs. The restart program shall include start time delays between successive commands to prevent demand surges or overload trips. The startup software shall initiate operation of self-test diagnostic routines. Upon failure of the FEP, if the database and application software are no longer resident or if the clock cannot be read, the FEP shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made. If the database and application programs are resident, the FEP shall resume operation after an adjustable time delay of from 0 to 600 seconds. The startup sequence for each FEP shall include a unique time delay setting for each control output when system operation is initiated.

2.7.1.2 Operating Mode

Each FEP shall control and monitor functions as specified, independent of communications with the Work Station. This software shall perform all FEP functions and FEP resident application programs as specified using data obtained from I/O functions and based upon the FEP real time clock function. When communications circuits between the FEP and the Work Station are operable, the FEP shall obtain real time clock updates and any required global data values transmitted from the system's real time clock. The FEP software shall execute commands after performing constraints checks in the FEP. Status and analog values, including alarms and other data shall be transmitted to the Work Station when communications circuits are operable. If communications are not available, each FEP shall function in stand-alone mode and operational data, including the latest status and value of each point and results of calculations, normally transmitted to

the Work Station shall be stored for later transmission to the Work Station. Storage for the latest 1024 values shall be provided at each Smart Field Panel. Each FEP shall accept software downloaded from the Work Station. Constraints shall reside at the FEP.

2.7.1.3 Failure Mode

Upon failure for any reason, each FEP shall perform an orderly shutdown and force all FEP outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device.

2.7.2 Functions

The Contractor shall provide all software necessary to accomplish the following functions, as appropriate, fully implemented and operational, within each Smart Field Panel, RTU, Unitary Controller and Universal Programmable Controller.

- a. Scanning of inputs.
- b. Control of outputs.
- c. Reporting of analog changes outside a selectable differential.
- d. Reporting of unauthorized digital status.
- e. Reporting of alarms automatically to Work Station.
- f. Reporting of I/O status to Work Station upon request.
- g. Maintenance of real time, updated by the Work Station at least once a day.
- h. Communication with the Work Station.
- i. Execution of FEP resident application programs.
- j. Averaging or filtering of all AIs.
- k. Constraints checks (prior to command issuance).
- l. Diagnostics.
- m. Portable tester/workstation operation as specified.
- n. Reset of PA by operator based on time and value.

2.7.2.1 Analog Monitoring

The system shall measure and transmit all analog values including calculated analog points. An analog change in value is defined as a change exceeding a preset differential value as specified. The record transmitted for each analog value shall include a readily identifiable flag which indicates the abnormal status of the value when it deviates from operator selectable upper and lower analog limits. Analog values shall be expressed in proper engineering units with sign. Engineering units conversions shall be provided for each measurement. Each engineering units conversion set shall include range, span, and conversion equation. A vocabulary of engineering unit descriptors shall be provided, using at least three

alphanumeric characters to identify information in the system.

2.7.2.2 Logic (Virtual) Points

Logic (virtual) points shall be software points entered in the point database which are not directly associated with a physical I/O function. Logic (virtual) points shall be analog or digital points created by calculation from any combination of digital and analog points, or other data having all the properties of real points, including alarms, without the associated hardware. Logic (virtual) points shall be defined or calculated and entered into the database by the Contractor. The calculated analog point shall have point identification in the same format as any other analog point. The calculated point shall be used in any program where the real value is not obtainable directly. Constants used in calculations shall be changeable online by the operator. Calculated point values shall be current for use by the system within 10 seconds of the time of any input changes.

2.7.2.3 State Variables

If an analog point represents more than two (up to 8) specific states, each state shall be nameable. For example, a level sensor shall be displayed at its measured engineering units plus a state variable with named states usable in programs or for display such as low alarm/low/normal/high/high alarm.

2.7.2.4 Analog Totalization

Any analog point shall be operator assignable to the totalization program. Up to eight analog values shall be totalized within a selectable time period. At the end of the period, the totals shall be stored. Totalization shall then restart from zero for the next time period. The program shall keep track of the peak and total value measured during the current period and for the previous period. The operator shall be able to set or reset each totalized value individually. The time period shall be able to be operator defined, modified or deleted online.

2.7.3 I/O Point Database/Parameter Definition

Each I/O point shall be defined in a database residing in the FEP. The definition shall include all physical parameters associated with each point. Each point shall be defined and entered into the database by the Contractor, including as applicable:

- a. Name.
- b. Device or sensor type (i.e., sensor, control relay, motors).
- c. Point identification number.
- d. Unit.
- e. Building number.
- f. Area.
- g. Installation.
- h. FEP number and channel address.

- i. KW (running).
- j. KW (starting).
- k. Sensor range.
- l. Controller range.
- m. Sensor span.
- n. Controller span.
- o. Engineering units conversion (scale factor).
- p. Setpoint (analog).
- q. High reasonableness value (analog).
- r. Low reasonableness value (analog).
- s. High alarm limit (differential return to normal).
- t. Low alarm limit differential (return to normal).
- u. High alarm limit (analog).
- v. Low alarm limit (analog).
- w. Alarm disable time period upon startup or change of setpoint.
- x. Analog change differential (for reporting).
- y. Alarm class and associated primary message test.
- z. High accumulator limit (pulse).
- aa. Status description.
- bb. Run time target.
- cc. Failure mode as specified and shown.
- dd. Constraints as specified.

2.7.4 Alarm Processing

Each FEP shall have alarm processing software for AI, DI, and PA alarms for all real and virtual points connected to that FEP.

2.7.4.1 Digital Alarms Definition

Digital alarms are those abnormal conditions indicated by DIs as specified and shown.

2.7.4.2 Analog Alarms Definition

Analog alarms are those conditions higher or lower than a defined value, as measured by an AI. Analog readings shall be compared to predefined high

and low limits, and alarmed each time a value enters or returns from a limit condition. Unique high and low limits shall be assigned to each analog point in the system. Analog alarm limits shall be stored in the FEP database. Each analog alarm limit shall have an associated unique limit differential specifying the amount by which a variable must return into the proper operating range before being annunciated as a return-to-normal-state. All limits and differentials shall be entered online by the operator in limits of the measured variable, without interruption or loss of monitoring of the point concerned. The program shall automatically change the high or low limits or both, of any analog point, based on time scheduled operations as specified, allowing for a time interval before the alarm limit becomes effective. In CPA applications, key the limit to a finite deviation traveling with the setpoint. The system shall automatically suppress analog alarm reporting associated with a digital point when that digital point is turned off.

2.7.4.3 Pulse Accumulator Alarms Definition

Pulse accumulator alarms are those conditions calculated from totalized values of accumulator inputs or PA input rates that are outside defined limits as specified and shown. PA totalized values shall be compared to predefined limits and alarmed each time a value enters a limit condition. Unique limits shall be assigned to each PA point in the system. Limits shall be stored in the FEP database.

2.7.5 Constraints

2.7.5.1 Equipment Constraints Definitions

Each control point in the database shall have FEP resident constraints defined and entered by the Contractor, including as applicable:

- a. Maximum starts (cycles) per hour.
- b. Minimum off time.
- c. Minimum on time.
- d. High limit (value in engineering units).
- e. Low limit (value in engineering units).

2.7.5.2 Constraints Checks

All control devices connected to the system shall have the FEP memory resident constraints checked before each command is issued to insure that no equipment damage will result from improper operation. Each command shall be executed by the FEP only after all constraints checks have been passed. Each command point shall have unique constraints assigned. High and low "reasonableness" values or one differential "rate-of-change" value shall be assigned to each AI. Values outside the reasonableness limits shall be rejected and an alarm message sent to the Work Station. Status changes and analog point values shall be reported to the workstation upon operator request, such as for reports, alphanumeric displays, graphic displays, and application programs. Each individual point shall be capable of being selectively disabled by the operator from the workstation. Disabling a point shall prohibit monitoring and automatic control of that point.

2.7.6 Diagnostics

Each FEP shall have self-test diagnostic routines implemented in firmware. The tests shall include routines that exercise memory. Diagnostic software shall be usable in conjunction with the portable tester/workstation. The software shall display messages in English to inform the tester's operator of diagnosed problems.

2.7.7 Control Sequences and Control Loops

Specific functions to be implemented are defined in individual system control sequences and database tables shown in the drawings, and shall include, as applicable, the following:

- a. PI Control: This function shall provide proportional control and proportional plus integral control.
- b. Two Position Control: This function shall provide control for a two state device by comparing a set point against a process variable and an established deadband.
- c. Floating Point Control: This function shall exercise control when an error signal exceeds a selected deadband, and shall maintain control until the error is within the deadband limits.
- d. Signal Selection: This function shall allow the selection of the highest or lowest analog value from a group of analog values as the basis of control. The function shall include the ability to cascade analog values so that large numbers of inputs can be reduced to one or two outputs.
- e. Signal Averaging: This function shall allow the mathematical calculation of the average analog value from a group of analog values as the basis of control. The function shall include the ability to "weight" the individual analog values so that the function output can be biased as necessary to achieve proper control.
- f. Reset Function: This function shall develop an AO based on up to two AIs and one operator specified reset schedule.
- g. Cooling/Heating Operation Program: Software shall be provided to change, either automatically or on operator command, the operating parameters, monitoring of alarm limits, and start-stop schedules for each mechanical system where such a change from cooling to heating and vice versa is meaningful. The software shall provide commands to application programs to coordinate cooling or heating mode operation. Software shall automatically switch facilities from cooling to heating, and vice versa, based on schedules or temperatures. All HVAC equipment and systems shall be assigned to the program.

2.7.8 Command Priorities

A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. The system shall require the latest highest priority command addressed to a single point to be stored for a period of time longer than the longest time constraint in the on and off states, insuring that the correct command

shall be issued when the time constraint is no longer in effect or report the rejected command. Override commands entered by the operator shall have higher priority than those emanating from applications programs.

2.7.9 Resident Application Software

The Contractor shall provide resident applications programs developed in accordance with paragraph GRAPHIC OBJECT ORIENTED PROGRAMMING to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide control of the systems connected to the UMCS. All application programs shall be resident and shall execute in the FEP, and shall coordinate with each other, to insure that no conflicts or contentions remain unresolved. The Contractor shall coordinate the application programs specified with the existing equipment and controls operation, and other specified requirements. A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. The system shall require the latest highest priority command addressed to a single point to be stored for a period of time longer than the longest time constraint in the ON and OFF states, insuring that the correct command shall be issued when the time constraint is no longer in effect or the rejected command shall be reported. Override commands entered by the operator shall have higher priority than those emanating from application programs.

2.7.9.1 Program Inputs and Outputs

The Contractor shall use program inputs listed for each application program to calculate the required program outputs. Where the specific program inputs are not available, a "default" value or virtual point appropriate for the equipment being controlled and the proposed sequence of operation shall be provided to replace the missing input, thus allowing the application program to operate. AIs to application programs shall have an operator adjustable deadband to preclude short cycling or hunting. Program outputs shall be real analog or digital outputs or logic (virtual) points as required to provide the specified functions. The Contractor shall select the appropriate input and output signals to satisfy the requirements for control of all systems as shown.

2.7.9.2 DDC Conditions

The Contractor shall provide software required to achieve the sequences of operation, parameters, constraints, and interlocks shown. Application software shall be resident in the FEP in addition to any other required software. In the event of a FEP failure, the controlled equipment shall continue to function in the failure mode shown.

2.7.9.3 DDC Sequences of Operation

The DDC sequences shown describe the actions of the control systems for the process variables, such as position, temperature, humidity or pressure.

- a. Control - The application software shall utilize proportional, proportional plus integral, or proportional plus integral plus derivative control with automatic self-tuning of the process variables shown.
- b. Status - Equipment operation shall be verified using the sensors shown.

- c. Alarms - The operation of the equipment shall be subject to the operational modes, conditions and logic described. A status feedback time delay (adjustable) shall be initiated on equipment startup or setpoint change to allow equipment to reach its operating setpoint.

2.7.9.4 Generator Monitoring and Ventilation Control

The software shall remotely monitor and control ventilation dampers operation based on Automatic Transfer Switch operational data. The program shall monitor Generator Room Temperature and Generator Run Status and position discharge and recirculation dampers to maintain the Room Temperature setpoint. All setpoints shall be adjustable.

2.8 WORK STATION EQUIPMENT

2.8.1 Workstation

These functions may be combined with the Main Control Room Field Panel.

2.8.1.1 Workstation Computer

The workstation computer shall be a standard unmodified digital computer of modular design. The CPU word size shall be 64 bits or larger. The operating speed of the processor shall be at least 800 MHz.

2.8.1.2 Workstation Memory

The computer shall contain at least 256 megabytes of memory, expandable to a minimum of 512 megabytes without additional chassis or power supplies.

2.8.1.3 Workstation Power Supply

Power supply shall have a minimum capacity of 250 watts.

2.8.1.4 Workstation Real Time Clock (RTC)

Accuracy shall be within plus or minus one minute per month. The RTC shall maintain time in a 24 hour format including seconds, minutes, hours, date, and month and shall be resettable by software. The RTC shall continue to function for a period of 3 months without power.

2.8.1.5 Workstation Serial Ports

- a. Two EIA ANSI/EIA/TIA-232-F serial ports shall be provided for general use.
- b. Adjustable data transmission rates from 9600 to 57.6 Kbps selectable under program control.

2.8.1.6 Workstation Parallel Port

An enhanced parallel port shall be provided.

2.8.1.7 Workstation Color Monitor

The monitor shall be as shown, but no less than 17 inches, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 millimeters. However, if the workstation functions are integrated

with the Main Control Room Field Panel, the monitor may be 12-inch SVGA-TFT color flat panel. The video output card shall support at least 256 colors at a resolution of 1280 by 1024 pixels at a minimum refresh rate of 70 Hz.

2.8.1.8 Workstation Keyboard

A 101 key keyboard having a minimum 64 character standard ASCII character set based on and ANSI X3.154 shall be furnished.

2.8.1.9 Workstation Disk Storage

A hard disk with controller having a maximum average access time of 10 milliseconds shall be provided. The hard disk shall provide a minimum of 10 gigabytes of formatted storage. Additionally, a PCMCIA slot with a removable minimum 500 megabyte hard drive shall be provided.

2.8.1.10 Workstation Floppy Disk Drives

Two high density floppy disk drives and controllers in 3-1/2 inch diameter size shall be provided.

2.8.1.11 Workstation Magnetic Tape System

A quarter inch cartridge magnetic tape system shall be provided. The system capacity shall be a minimum of 2.0 gigabytes minimum per tape. Each tape shall be computer grade, in a rigid cartridge with spring-loaded cover and write-protect switch.

2.8.1.12 Workstation Modems

Modem shall operate at 56,000 bps, full duplex on circuits using asynchronous communications. It shall have error detection, auto answer/auto dial, and call progress detection. The modem shall meet the requirements of ITU V.34, ITU V.42 for error correction and ITU V.42 bis for data compression standards. Modem shall be suitable for operating on unconditioned voice grade telephone lines in conformance with 47 CFR 68.

2.8.1.13 Workstation Audible Alarm

The manufacturer's standard audible alarm shall be provided.

2.8.1.14 Workstation Mouse

A mouse with a minimum resolution of 400 dots per inch shall be provided.

2.8.1.15 Workstation CD-ROM Drive

A CD-ROM drive having a nominal storage capacity of 650 megabytes shall be provided. The CD-ROM drive shall have the following minimum characteristics:

- a. Data Transfer Rate: 900 Kbps.
- b. Average Access Time: 150 milliseconds.
- c. Cache memory: 256 Kbytes.
- d. Data throughput: 1 Mbyte/second, minimum.

2.8.2 Network Laser Printer

The laser printer shall meet the following minimum requirements:

- a. Resolution: 600 by 600 dots per inch.
- b. Printing Time: 10 pages per minute.
- c. Data Buffer Size: 18 Megabytes.
- d. Media Size: 8.5 X 11 and 8.5 X 14 inches.
- e. Interfaces: Parallel port & LAN interface.
- f. Paper Cassette: 250 sheet capacity.

2.8.3 LAN Equipment

All LAN equipment shall fully comply with IEEE Std 802.3 (10 BASE 2 or 10 BASE T or greater) Ethernet networks or IEEE Std 802.4 Arcnet networks.

2.8.3.1 Coaxial Cables and Connectors

- a. Cable shall be Type RG-58/U coaxial cable specifically designed for Ethernet applications or RG-62 coaxial cable specifically designed for ARCNET application compatible with the LAN and shall have a tinned copper conductor with polyethylene insulation, tinned copper braid shield, PVC jacket and minimum shield coverage of 95%. Connections to the LAN shall be made using BNC Female-Male-Female T-connectors utilizing a radiation suppressing sleeve supporting the sheath. LAN terminations shall be made using 50 or 93 ohm resistors as required by the LAN.
- b. For projects which require multiple types of cable jackets or special types of cable, indicate the type of each cable on the drawings. For cables which require special jackets, such as those subject to corrosive environments, provide a description of the environmental requirements.
- c. Select the appropriate cable jacket rating (such as CMR, CMG, CMP, OFNG, OFNR, or OFNP) based on NEC or local code requirements. If there is a potential for mixed rating of the same cables, use the highest rating only.
- d. Use fiber optic cable for backbone data service, unless expanding an existing site where other backbone cable types are required or requested by user. Unshielded twisted pair cable is not recommended for backbone cable, but if requested by the user, should meet or exceed the performance of the horizontal distribution (station) cable.

2.8.3.2 Cable and Accessories

- a. Riser cable shall meet the requirements of ICEA S-80-576 and EIA ANSI/TIA/EIA-568-A for Category 5, 100-ohm UTP cable. Cable shall be label verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Conductors shall be solid untinned copper 24 AWG. Cable shall be rated CM per NFPA 70.

- b. Horizontal cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A and for Category 5, horizontal UTP cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Conductors shall be solid untinned copper 24 AWG. Cable shall be rated CM per NFPA 70.
- c. Backbone cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A for Category 5 UTP cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Cable shall be rated CM per NFPA 70. Cable shall have band markings every 8 feet for transceiver tap placement.
- d. Outlets shall be eight-position modular jacks that meet the requirements of EIA ANSI/TIA/EIA-568-A for Category 5 connecting hardware. Outlet wire terminations shall be insulation displacement contact (IDC) type. Jack pin/pair configuration shall be T568A per EIA ANSI/TIA/EIA-568-A. Outlets shall be unkeyed. Faceplates shall be provided and shall be ivory in color, impact resistant plastic, single gang. Mounting plates shall be provided for system furniture and shall match the furniture system in color.
- e. Patch panels shall consist of eight-position jacks arranged in rows or columns on wall mounted frames. Cable terminations shall be insulation displacement contact (IDC) type. Patch panel components shall meet or exceed the requirements of EIA ANSI/TIA/EIA-568-A for Category 5 connecting hardware. Jack pin/pair configuration shall be T568A per EIA ANSI/TIA/EIA-568-A. Jacks shall be unkeyed.
- f. Patch cords shall be cable assemblies consisting of flexible, twisted pair stranded wire with eight-position plugs at each end. Patch cords shall meet the requirements of EIA ANSI/TIA/EIA-568-A for Category 5 UTP patch cords. Cable shall be label verified. Cable jacket shall be factory marked at regular intervals indicating the verifying organization and performance level. Patch cords shall be wired straight through such that pin numbers are identical at each end and shall be paired to match T568A patch panel jack wiring per EIA ANSI/TIA/EIA-568-A. Patch cords shall be unkeyed. Patch cords shall be factory assembled.

2.8.3.3 Network Interface Card

Network interface cards shall be provided for LAN management functions and for serving devices as shown on the drawings. The network interface card shall use a 16 bit interface to the data bus. It shall be supplied with an on-board RJ45 connector and transceiver for direct connection to the LAN. It shall also have an auxiliary unit input port for performing diagnostics. On-board buffer memory of at least 16K bytes shall be included to prevent loss of data packets.

2.8.3.4 Bridges

Bridges shall provide communication between local area networks segments as shown. Bridges shall support protocols utilized in the local area networks. The bridge shall include interface equipment to support data

rates shown, but no less than 14,400 bps. Bridges with multiple communication lines shall be modular, expandable to a minimum of 16 ports. Each port shall have LED indicators for monitoring network status. The bridge shall be self-configuring and protocol transparent.

2.8.3.5 Hubs

Network hubs shall provide communication between network devices using minimum 10 BASE T cables. Network hubs shall support protocol utilized in the LAN. Network hubs shall be modular and expandable from a minimum of 16 ports up to 48 ports. Each port shall have LED indicator for network monitoring status. Network hubs shall permit online network changes without disturbing network devices. Malfunctioning network devices shall be automatically removed from service without shutting down the network.

2.8.4 Communications Network Interface

The Work Station shall include modems, data connecting units, and other line terminations as required for each communications circuit connected to the communication network shown.

2.8.5 Network Security Callback Modem

The network security callback modem shall be a stand-alone modem with a security feature to call back the originating number after receiving a call. The modem shall be programmable to set callback telephone numbers. It shall operate at speeds up to 28,800 bps full duplex on circuits in the asynchronous mode. The modem shall have error detection, auto answer/auto dial, call progress detection, and the appropriate security safeguards, including passwording, to allow for call back of predefined numbers associated with each password, after receiving a call. Modem shall meet the requirements of ITU V.32 bis modems. Modem shall be suitable for operating on unconditioned voice grade telephone lines in accordance with 47 CFR 68.

2.8.6 Uninterruptible Power Supply (UPS)

A self contained UPS suitable for installation and operation at the Work Station, shall be provided sized to provide a minimum of 20 minutes of operation of the Work Station Equipment but not less than 3000 watt capacity. Equipment connected to the UPS shall not be affected in any manner by a power outage of a duration less than the rated capacity of the UPS. UPS shall be complete with all necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power. The UPS shall be equal to a minimum of 3.0 kVA/2.1 kW, 1-phase, 120 volt, 60 Hz, with built-in surge protection.

2.9 WORK STATION SOFTWARE

The Work Station software shall support all specified functions, plus expansion to a minimum of 32,000 points, complete with their point database. The Work Station shall be online at all times and shall perform all required functions as specified.

2.9.1 Operating System

The operating system shall perform the following functions:

- a. Support multiuser operation with multiple tasks for each user.
- b. Support operation and management of all peripheral devices.
- c. Provide file management functions for disk I/O, including creation and deletion of files, copying of files, a directory of all files including size and location of each, sequential and random ordered records.
- d. Provide printer spooling.
- e. Support for the specified LAN interface.

2.9.2 Real Time Clock Synchronization

The system shall synchronize each Work Station computer real time clock within one second and at least once per day automatically, without operator intervention and without requiring system shutdown. The Work Station computer shall initiate a call once per day automatically to the NIST to obtain the correct time and date and update the real time clock. The Work Station computer shall generate a report showing the time difference.

2.9.3 Database Definition Process

Software shall be provided to define and modify each point in the database using operator commands. The definition shall include all physical parameters and constraints associated with each point. Each database item shall be callable for display or printing, including EEPROM, ROM and RAM resident data. Each point shall be defined and entered into Work Station database by the Contractor.

2.9.4 System Reaction

- a. Under system normal heavy load, no more than 10 seconds shall lapse from the time a digital status alarm or analog alarm occurs at a FEP until the change is displayed at the operator's workstation. The total system response time from initiation of a control action command from the workstation, to display of the resulting status change on the workstation shall not exceed 20 seconds under system normal heavy load conditions assuming a zero response time for operation of the FEP's control device.
- b. System normal heavy load conditions are defined as the occurrence throughout the system of a total of three status changes, three digital alarms, three analog high or low limit alarms, and three analog quantity changes within the high and low limits during a single 1-second interval. This number of similar occurrences shall repeat on a continuous basis during successive 1-second intervals for a period of 2 minutes. Specified system operation and performance shall be maintained under system normal heavy load conditions.
- c. The system normal heavy load conditions as specified shall have 50% of the changes and alarms, including no less than one of each type, occurring at a single FEP with the remaining changes and alarms distributed among the remaining FEPs. All system normal heavy load conditions shall be introduced to the system via AIs and DIs. The alarm printer shall continue to print out all

occurrences, including time of occurrence, to the nearest second.

2.9.5 Report Generator

Software shall be provided with commands to generate and format reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. The destination of each report shall be selectable by the operator. Reports shall use database values and parameters, values calculated using the real time static database; with the reports subsequently stored on hard disk, tape, or WORM drive. Reports shall be spooled allowing the printing of one report to be complete before the printing of another report commences. Database parameters used in reports shall be assignable by the operator. Dynamic operation of the system shall not be interrupted to generate a report. The report generation mode, either periodic, automatic or request, shall be operator assignable. The report shall contain the time and date when the sample was taken, and the time and date when the report was printed. Software shall be provided to format and store on a removable diskette all data, trends, profiles, reports and logs specified herein in a defined, standard format such as ASCII text or Data Interchange Format (DIF) for export and further processing by other computer systems. Data transfer function shall be accessible by operator command from any workstation, subject to password.

2.9.5.1 Periodic Automatic Report Modes

The system shall allow for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, end of period, and the output peripheral.

2.9.5.2 Request Report Mode

The system shall allow for the operator to request at any time an immediate printout of any report.

2.9.5.3 Creation of Reports

- a. Status Report: The system shall include software to produce reports on the current status of any equipment or parameters in the database, including:
 - (1) An individual equipment item sensor or control device.
 - (2) A list of equipment, sensors, or control devices, by category, such as building, unit or FEP or I/O point database parameter.
- b. Correlated Alarm Reports: The software shall provide for generating a report to include parameters dependent on a specific alarm in order to obtain detailed diagnostics of the I/O point database when an alarm condition occurs. The software shall include:
 - (1) Identification of the initiating alarm.
 - (2) Identification of correlated dependent parameters.
 - (3) Automatic reporting of current status of each dependent parameter when an alarm condition is detected in the initiating point. Provision shall be made for 64 initiating alarms each having up to 32 dependent parameters.

- c. Profile Reports: The software shall provide for generating profile reports by sampling and storing defined parameters on an operator assignable and selectable time interval basis such as an interval of 15 minutes for a period of 1 month and shall include:
- (1) Power consumption (value vs time).
 - (2) Power demand (value vs time).
 - (3) Analog (value vs time).
 - (4) Two variable (point) profiles.
 - (5) Equipment subsystem profiles (value vs value or value vs time). Sixty-four profile reports shall be provided each with 1000 samples of up to 8 parameters.

2.9.6 Standard Reports

The following standard reports shall be provided:

Reports shall include the starting and ending time of the reporting interval. Longer reporting intervals shall be accumulated by totalizing the results of shorter intervals.

- a. Alarm Report: Outstanding alarms by building or unit, including time of occurrence.
- b. Lockout Report: Points disabled, including time disabled, and identification of operator disabling the point.
- c. Analog Limit Report: An analog limit and differential summary selectable to allow a single point, analog points within a unit, analog points within a building, and analog points for the project. Displays and logs shall still indicate the current value of these points even though alarming has been suppressed. The report shall include:
 - (1) Point analog value.
 - (2) Engineering units.
 - (3) High limit.
 - (4) Low limit.
 - (5) High reasonableness limit.
 - (6) Low reasonableness limit.
 - (7) High limit differential.
 - (8) Low limit differential.
 - (9) Analog value change differentials.
- d. Run Time Reports: A report totalizing the accumulated run time of individual pieces of equipment. The operator shall be able to

select the following subsets of equipment:

- (1) Individual equipment items without status feedback.
 - (2) Individual equipment items with analog or digital status feedback.
 - (3) Equipment type, such as air handling units.
 - (4) Specific equipment sizes by types, such as all motors over 20 hp.
 - (5) Equipment by physical grouping. The system shall maintain statistics on a number of equipment items equal to the number of digital inputs and outputs. Run time shall be totaled up to 9999 hours. Reports shall be generated on equipment which has reached the target run time specified in the database. The software will provide for manual and automatic reset, operator selectable and settable for each individual run time totalized, reset to zero upon generation of the report, as necessary.
- e. Out-Of-Service Report: A report to list out-of-service devices in each Work Station, each DTS circuit, and each FEP.
 - f. Static Database Reports: A listing of the values of fixed parameters and constraints defining the characteristics of the system and the connected equipment. Provide operator commands to list the entire static database or to list an operator selected building, unit, point, or FEP. Each value shall be listed with appropriate units in English.
 - g. Real-Time Database Reports: A list of the values of dynamic variables including all AIs, DIs, and calculated points. These data shall be sampled concurrently, including year, month, day, hour, and minute on the report. Operator commands shall allow for listing the entire real-time database or an operator selected installation, building, unit, point, or FEP. Each value listed shall be identified in English.
 - h. Communication Network Circuit Report: A listing of all communication circuits from each Work Station to each Smart Field Panel; and from each Smart Field Panel to its RTUs, Unitary Controllers, and Universal Programmable Controllers. The report shall include for each communication circuit:
 - (1) Operator selected number (1-99) of retransmission attempts.
 - (2) Total number of transmissions attempted (0-64,000).
 - (3) Present consecutive retries (in progress) (1-99).
 - (4) Total number of retries (cumulative to 32,000).
 - i. Network Security Callback Modem Log: A listing of all incoming and outgoing calls from each Network Security Callback Modem at all locations in the UMCS.
 - j. Significant Events Report: The significant events report shall include system events in chronological order. The size of the

report shall be user definable and shall be stored at a universally retrievable system location, accessible from any workstation. The report shall have a user selectable/definable query, and the report shall include event times and descriptions for all items queried. All queries shall be based on the following:

- (1) Time.
- (2) Date.
- (3) Point name or acronym.
- (4) Control operations.
- (5) Status report.
- (6) System failures.
- (7) Control failures.
- (8) Data transmission failures.
- (9) User login and transactions.
- (10) Time schedules.
- (11) Point types.

2.9.7 Data Interchange

Software shall be provided to format and store on a removable diskette the data, trends, profiles, reports and logs as specified in a defined, standard format such as ASCII text or DIF for export and further processing by other software and/or computer systems.

2.9.8 Workstation Software

Each workstation shall be provided with operator interface operating system software as follows:

- a. Windowing System: Each workstation shall be provided with a windowing system software package with communication and programming capabilities. The windowing system shall also include a user application multiple window management program to organize the graphic display and shall conform to graphic display hierarchy shown.
- b. Graphical User Interface: Each workstation shall be provided with an object-oriented mouse driven graphical user interface. The graphical user interface shall include a set of desktop utilities as listed below.
 - (1) File management.
 - (2) Shell tool.
 - (3) Calculator.

- (4) Text editor.
- (5) Icon editor.
- c. Display Information: The Workstation shall display information necessary to support all requirements specified, including:
 - (1) Operator commands.
 - (2) Alarm notification.
 - (3) Reports.
 - (4) System graphics as specified and as shown, incorporating real time data.
 - (5) Curve plotting.
- d. System Graphics Implementation: System graphics displays shall be hierarchial displays which integrate real time data into the display. System graphics shall reflect actual system configuration and points required for the sequence including system wide data such as outside air temperature and humidity. Each system schematic shall be included as a separate display keyed to the building in which it is installed. Displays of all systems and points shown shall be included. Different colors textures, and use of inverted video shall be used for various components and real time data. Colors and textures shall be uniform on all displays. Data associated with a display shall be updated within 10 seconds of the digital status change or the analog change in excess of the analog change differential. When a point is in alarm, the representation for that point shall be distinctly distinguishable until acknowledged, and shall change to indicate acknowledgement until the alarm condition no longer exists. Floor plans shall display equipment zones, associated systems and points. Zones with space temperature exceeding alarm limits shall be color-filled on the floor plan with red in a distinguishable texture for exceeding the high limit and with blue in a distinctly different texture for exceeding the low limit. Colors shall be used to allow rapid recognition and ease of interaction. Any real time data which is not current, due to FEP communications failure, FEP failure, or point out of service, shall be highlighted or flagged. Each display shall clearly distinguish between the following types of information:
 - (1) Real-time updated data.
 - (2) User-entered data.
 - (3) Bad or out-of-scan data.
 - (4) Disabled controls (control inhibited).
 - (5) Disabled sensors (reporting inhibited).
 - (6) Devices in alarm (unacknowledged).
 - (7) Out-of-limits data.

- e. Display Editor: The display editor shall enable the user to create, modify, and delete displays. The primary use shall be for adding and modifying one-line diagrams, status displays, system summaries, and system directories, as Smart Field Panels/RTUs/Unitary Controllers/Universal Programmable Controllers and new points, data, and other necessary changes are made. The function of linking the dynamic fields with the database shall be handled by a separate software module which shall be executed automatically as the last step of the database generation and modification procedure. The basic functions shall include:
- (1) Create a new graphic.
 - (2) Modify a portion of a graphic.
 - (3) Delete a graphic.
 - (4) Call up a graphic.
 - (5) Cancel the display of a graphic.
 - (6) Assign conditions which automatically initiate the display.
 - (7) Overlay alphanumerics and graphics.
 - (8) Save new, modified, or existing graphics as new graphics.
 - (9) Integrate real-time data with the display.
 - (10) Define the background color.
 - (11) Define the foreground color.
 - (12) Locate the symbols.
 - (13) Position and edit alphanumeric descriptors.
 - (14) Establish connecting lines.
 - (15) Establish sources of latest data and location of readouts.
 - (16) Display analog values as specified.
 - (17) Cursor control (up, down, right, left).
 - (18) Create and display alphanumeric displays.
 - (19) Create and display reports.
 - (20) Define and create symbols. In constructing the static or fixed background portion of a single-page or multi-page display where the basic formats and dynamic field locations are identical in the different pages, the user shall not be required to repetitively enter the same information for each page.
- f. Charting: The workstation shall allow the user to display data as:
- (1) Trend Charts: The system shall support the presentation of data with time on the X-axis (horizontal) and amplitude on the

Y-axis (vertical). A minimum of 360 15-minute divisions of 24 1-hour divisions, and 31 1-day divisions shall be displayed on the X-axis. A minimum of 10 equal divisions, in engineering units, shall be displayed on the Y-axis. The start and end date/time shall be user definable on the hour starting at midnight.

(2) Bar Chart: The system shall support presentation of data in bar chart form with a minimum of 360 15-minute divisions and 31 1-day divisions to be displayed on the X-axis.

- g. System Menus and Displays: The user shall be able to call up the following displays by multiple character entry, dedicated function key, or by icon and shall be able to page forward and backward on linked multiple page displays. The system menu and index displays shall also contain icons which can be used to call up subsequent displays.

(1) System Menu (list of all graphics and menus).

(2) Index (list of all Smart Field Panels, RTUs, Unitary Controllers, and Universal Programmable Controllers).

(3) Alarm Summary (list of all uncleared alarms).

(4) Abnormal Summary (list of all devices not in normal state; keeps track of alarm conditions which have been cleared).

(5) Data Communications Summary (listing of availability for each communication channel, by statistically processing the number of transmission errors, outages, and other abnormal conditions for each channel)

2.9.8.1 System Graphics Symbols

The system graphics software shall include a library of the symbols listed, plus 100% expansion. Symbols shall conform to ASHRAE Hdbk-IP where applicable. The software shall allow the operator to create, modify, delete, call-up, list, and store display symbols. A library of callable display symbols shall be furnished, including:

- a. Pump: Right hand (RH), Left hand (LH), Upflow (U), Downflow (D).
- b. Valve, Two-Way: Horizontal (H), Vertical (V).
- c. Valve, Three-Way: H, V.
- d. Flow Element: H, V.
- e. Temperature Sensor: H, V.
- f. Pressure Sensor: H, V.
- g. Humidity Sensor: H, V.
- h. Air Handling Unit, Single Deck.
- i. Fan: r.h., IH, U, D.
- j. Air Compressor.

- k. Vertical Piping and Ductwork.
- l. Horizontal Piping and Ductwork.
- m. Unit Heater.
- n. Pressure Reducing Valve: H, V.
- o. Damper: H, V.
- p. Limit Switch: H, V.
- q. Flow Switch: H, V.
- r. Temperature Switch: H, V.
- s. Pressure Switch.
- t. Coil: H, V.
- u. Solenoid Valve: H, V.
- v. Filter: H, V.
- w. Condensing Unit.
- x. Custom symbols as shown.

2.9.8.2 Hard-Copy Screen Request

Each workstation shall be able to obtain a hard copy (both monochrome and color) of the monitor display being viewed. This shall be an exact "snapshot" of the data and device symbols shown on the selected monitor. Printer output format shall be an exact image of its corresponding display on the monitor. The hard-copy output shall be selectable to the workstation printer or to any network printer.

2.9.8.3 Alarms

The software shall notify an operator of the occurrence of an alarm condition. The UMCS alarm history shall be stored in an ASCII file on disk and shall be recallable by the operator using the report generator. Alarm messages shall take precedence over reports, and reports shall take precedence over logging of operator actions. A minimum of the most recent 25 system alarms shall be directly available at each workstation and Work Station computer. Alarms shall be displayed in chronological order with the oldest unacknowledged alarm displayed first. Operator acknowledgment of one alarm shall not be considered as acknowledgment of any other alarm nor shall it inhibit reporting of subsequent alarms. Each alarm shall be assignable to any one or any combination of workstations by time of day and day of week. Additionally, the alarms shall be logged at the Work Station computer. Alarm acknowledgment at any given workstation shall not constitute acknowledgment for any other workstation in the system. Alarm data to be displayed and stored shall include:

- a. Identification of alarm.
- b. Date and time to the nearest second of occurrence.

- c. Device or sensor type.
- d. Limit exceeded (if analog).
- e. Engineering units.
- f. Current value or status.
- g. Alarm class.
- h. Alarm messages.

2.9.8.4 Digital Alarms Definition

Digital alarms are those conditions indicated by switching contacts in the connected equipment as specified and shown. These alarms shall be subject to immediate reporting, within the alarm response time, at the Work Station regardless of other considerations such as the overall time constant associated with a controlled system or process.

2.9.8.5 Analog Alarms Definition

Analog alarms are those high or low conditions calculated from a measured analog parameter in the database as specified and shown. These alarms shall be subject to immediate reporting, within the alarm response time, at the Work Station, regardless of other considerations such as the overall time constant associated with a controlled system or process. The FEPs analog readings shall be compared to predefined high and low limits, and alarmed via uplink to the Work Station each time a value enters or returns from a limit condition. Unique high and low limits shall be assigned to each analog point in the system. High and low alarm limits shall be stored in the Work Station and FEP databases. Operator-requested analog displays, reports, and summaries shall flag each analog point in alarm. Each high and low limit shall have an associated unique limit differential specifying the amount by which a variable must return into the proper operating range before being annunciated as a return-to-normal-state. Limits and differentials shall be enterable on-line by the operator in units of the measured variable, without interruption or loss of monitoring of the point concerned. The program shall automatically change the high or low limits, or both, of any analog point, based on time scheduled operations as specified, allowing for a time interval before the new alarm limit becomes effective. For those applications where setpoint adjustments are made, the alarm limit shall be keyed to a finite deviation traveling with the setpoint. The system shall automatically suppress control functions and analog alarm reporting associated with a digital point when that digital point is turned off or reset.

2.9.8.6 Alarm Messages

A unique message with a field of 60 characters shall be provided for each alarm. Assignment of messages to a point shall be an operator editable function. Secondary messages shall be assignable by the operator for printing to provide further information, such as telephone lists or maintenance functions, and shall be editable by the operator. The system shall provide for 100 secondary messages with a field of 25 lines of 60 characters each.

2.9.8.7 Alarm Classes

Classes of alarms which will be identified for each item, include:

- a. Class 1 (Critical): Display, print, and audible alarm at occurrence and at return-to-normal. Acknowledgment by the operator shall be required at occurrence and at return-to-normal.
- b. Class 2 (Informational): Display, print, and audible alarm at occurrence and at return-to-normal. No acknowledgment is required unless otherwise shown.

2.9.8.8 Pop-up Note Function

A pop-up note function shall be included with each workstation, providing the operator a capability of noting any data which may be associated with alarms or with any other event. A note created by an operator shall be automatically called up when any other workstation calls up the associated point, alarm, or alarm summary. The pop-up note function shall also support free form entry of data which can be used by any workstation operators as general reminders or instructions.

2.9.8.9 Graphical Object Oriented Programming

The system shall include a graphical object oriented programming function which shall be used to create all control sequences utilized in FEPs, except for Unitary Controllers. This function shall reside in the Work Station and Workstations to create, modify, and test software for FEP resident programs. The graphical object oriented programming function shall provide programming elements to be connected together to create a logic diagram. The diagram shall be compilable to produce executable code for the FEP. The graphical object oriented programming function shall include elements for mathematical, logical, timing, setpoint, display and input/output functions to create logic diagrams that represent sequences of operation. Program elements shall be able to be combined into a custom template which can then be used as a standard function. Program checkout and debug facilities shall include display of real-time and/or simulated system variables and points on the programming screens. The user shall be able to fix or force values of variables to enable program checkout during debugging. The programming function shall provide for the following:

- a. Creation, modification, and testing of programs. Modular application software, control sequences, and PID control loops and database information shall be used in the development of programs.
- b. Editing FEP source code.
- c. Conversion of source programs into executable object code.
- d. Debugging operations using FEP test set.
- e. Saving and retrieving source and executable object code.
- f. Using the portable tester/workstation for loading files directly into the FEP.
- g. Uploading of existing FEP programming and database information and downloading of FEP programming and database information.

2.9.9 Command Software

The system shall accept English language operator commands for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation. The operator commands shall be usable from Work Station computer and workstation keyboards with individual operator passwords as specified.

- a. Command Input: Operator's commands shall be full words and acronyms selected to allow operators to use the system without extensive training or data processing backgrounds. The system shall prompt the operator in full words and acronyms for all required information, identifying acceptable command formats. The operator's response shall be a word, phrase, or acronym including parameters where required.
- b. Command Input Errors: The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors. The system shall explain to the operator why the command cannot be executed. Conditions for which operator error assist messages shall be generated include:
 - (1) The command used is incorrect or incomplete.
 - (2) The operator is restricted from using that command.
 - (3) The command addresses a disabled or out of service point.
 - (4) The command addresses a point which does not exist.
 - (5) The command would violate constraints.
- c. Special Functions: The system shall support the following special functions by using a mouse, in addition to all other commands specified:
 - (1) HELP: used to produce a display of all commands available to the operator. The HELP command, followed by a specific command shall produce context sensitive listing with a short explanation of the purpose, use, and system reaction to that command.
 - (2) START/ENABLE: used to manually start equipment and to enable monitoring and control of points.
 - (3) STOP/DISABLE: used to manually stop equipment and to disable monitoring and control components.
 - (4) DISPLAY DIAGRAM: used to display diagrams of specific utility systems or other systems as specified.
 - (5) DIAGRAM DEVELOPMENT: used to develop diagrams of specific utility systems or other systems as specified.
 - (6) AUTO/OVERRIDE: used to override or return a point to automatic operation.
 - (7) PRINT REPORT: allows the operator to initiate printing of reports.

- (8) CONFIRM ACTION: used to confirm that the desired command sequence has been correctly entered and is to be executed.
- (9) CANCEL ACTION: performs the opposite function of the CONFIRM ACTION, usable at any time prior to executing CONFIRM ACTION.
- (10) MEMO PAD: used by operator to create, store and retrieve pop-up notes.
- d. Operator's Commands: The operator's commands shall provide the means for entry of control and monitoring commands, and for retrieval of information. Processing of operator commands shall commence within 5 seconds of entry, with some form of acknowledgment provided at that time. The operator's commands shall perform tasks, including:
 - (1) Request a display of any digital, analog, or accumulator point, or any group of related points.
 - (2) Startup and shutdown selected systems or devices.
 - (3) Initiate reports.
 - (4) Modify time and event scheduling.
 - (5) Modify analog limits.
 - (6) Adjust setpoints.
 - (7) Adjust control loop gain constant.
 - (8) Adjust control loop integral constant.
 - (9) Select manual or automatic control modes.
 - (10) Enable and disable individual points at individual FEPs.
 - (11) Enable and disable individual FEPs.
 - (12) Define points.
 - (13) Generate and format reports.
- e. Level of Addressing: Five levels of addressing for identification shall be provided as follows:
 - (1) Point - the individual sensor or control device within a unit.
 - (2) Unit - the unit that a point is associated with, such as an AHU.
 - (3) Building - the building that a point is located in or near.
 - (4) Area - the area that a building is located in or near.
 - (5) Facility - Installation included in the UMCS.
- f. System Access Control: A minimum of 256 passwords shall be usable

with the UMCS software. The system shall display the operator's names or initials on the monitor. The system shall print the operator's name or initials, action, date, and time on the printer at log-on and log-off. The password shall not be displayed or printed. The system shall maintain an ASCII disk file logging all activity of the system. This file shall maintain, as a minimum, a record of all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications. The activity log shall be maintained at the Work Station computer. The system shall automatically provide a mechanism for archiving the log files for long term record storage. Each password shall be definable and assignable for the following:

- (1) Commands usable.
- (2) Access to operating system.
- (3) Access to command software.
- (4) Access to applications software.
- (5) Individual points which are to be accessed.
- (6) Access for alarm assignments.
- (7) Access to workstations.
- (8) Access to groups of points.

2.9.10 FEP and DTS Circuit Alarms

The system shall supervise each FEP, I/O function and DTS circuit for alarm reporting, including:

- a. FEP not responding.
- b. FEP responding (return to normal).
- c. Smart Field Panel to Work Station DTS circuit high error rate.
- d. Smart Field Panel to RTU/Unitary Controller/Universal Programmable Controller DTS circuit high error rate.
- e. Smart Field Panel/Work Station RTC error more than 15 seconds (adjustable).
- f. FEP intrusion alarm.
- g. FEP offline.
- h. FEP online (return to normal).
- i. FEP failure (self-diagnostics).
- j. Point not responding to command.
- k. Point change of state without command.

2.9.11 Work Station Database

The Work Station database shall be stored on disk, optical disk drive, and memory. The static database shall be downloadable as required to FEPs in the system.

2.9.11.1 Real Time Database

The real time database includes those variables which change with time or conditions including all DIs, AIs, PAs, and virtual (logic) points. It may reside in the FEPs only, or additionally at the Work Station computer.

2.9.11.2 Real Time Database Update

The real time database shall be updated from the field, allowing the operator to select update times from 10 minutes to 24 hours, in increments of one minute.

2.9.11.3 Static Database

The static database includes those fixed parameters and constraints from all FEPs which define the characteristics of the system and I/O functions such as alarm limits, start/stop times, point names, FEP channel addresses, and sensor spans.

2.9.11.4 Work Station Static Database Update

A copy of each FEP's static database shall be updated automatically once per day, or upon demand from the Work Station database.

2.9.11.5 Workstation Access to Real Time Data

Any workstation connected to the Work Station via the DTS, or via a dial-up telephone circuit, shall have access to that Work Station's real time data. Display of data shall commence within 15 seconds.

2.9.12 Historical Data Storage and Retrieval

A historical data storage and retrieval function shall be provided at the Work Station to collect and store real-time data from all Work Stations. This function shall be a general purpose data storage and retrieval function in addition to other data storage requirements. The function shall have the capability to collect and store alarm status changes, point values, events and operator commands, and system responses. The storage function shall also have the capability to collect and store multiple sets of analog data at pre-specified sampling rates. This function shall have the capability to retain at least 480 megabytes of historical data on hard disk for pre-specified time periods, up to four days for short-term analysis, and then output the data to the optical disk drive for long-term retention. The retention period for each historical data file shall be independently specified. The operator shall also be able to selectively recall short-term data stored on hard disk for presentation on workstation displays in a tabular trend report format. Retrieval and printing of the contents of any selected historical data file shall be available to any workstation using the supplied data retrieval and report generation program. The report generation program shall decode and format the data. The output of the report generation program shall be capable of being shown on workstation, printed in a report, or stored. Each hard disk or WORM drive file shall be self-defining to allow data elements to be identified

and accessed even if changes, additions and deletions have occurred in the real-time database.

2.9.13 Analog Monitoring

The system shall measure, transmit, and display analog values, including calculated analog points. Differential measurements shall be displayed as positive or negative values with respect to their reference points shown. An analog change in value is defined as a change exceeding a preset differential value as specified. Each analog change in value shall be operator selectable and settable to provide for a minimum reporting change in value of one-half the specified end-to-end accuracy of the measured variable. Displays and reports shall express analog values in proper engineering units with sign. The Contractor shall provide 128 different sets of engineering unit conversions. Each engineering conversion unit shall include range, span, and conversion equation.

2.9.14 LAN Software

A network operating system shall be supplied as part of the LAN software. The network operating system shall support network device access to the Work Station. The system shall provide workstation access to the Work Station as a virtual terminal. The network shall provide network access to shared peripherals. The LAN software shall provide for transparent communication with any node on the system. The LAN software shall support the following:

- a. Access control to the Work Station computer and workstations. Operators shall be able to perform all specified functions, given the proper passwords, including database definition/ modification, graphic creation/modification, and trending.
- b. Workstations running existing MS DOS applications in a window, and allowing those existing MS DOS applications access to files of historical and trend data.
- c. Support operation in multiple sessions.
- d. Other functions and configurations shown.

2.10 STARTUP

The system shall automatically perform a cold start (Work Station and FEPs off-line) upon application of power, and shall be in full operation as specified within 1 hour. The system shall automatically perform a warm start (Work Station off-line, FEPs online) upon application of power without human intervention, and shall be in full operation as specified within 15 minutes. The Work Station computer shall review and enable programs that should be running at that time, including the restart of any automatic control programs resident at the Work Station computer.

2.10.1 Recovery From Power Failure

When a power failure occurs at the Work Station or FEP, the system shall automatically start upon restoration of power and the programs shall be restarted in a manner to assure an orderly resumption.

2.10.2 FEP Restart

An FEP restart program based on detection of power failure at each FEP shall be provided. Upon restoration of power to the FEP, the FEP shall obtain time of day from the system's real time clock, restart equipment, and restore loads to the state at time of power failure, or to the state as commanded by time programs or other overriding programs. Start time delays between successive commands to prevent demand surges or overload trips shall be provided.

2.11 DATA COMMUNICATION REQUIREMENTS

UMCS data communications shall support the specified functions and UMCS configuration shown.

2.11.1 Work Station/Workstation

Each workstation shall be able to communicate with the Work Station as a virtual terminal. The Workstation shall be able to initiate uploads or downloads of programs and resident data, including parameters of connected systems FEPs and devices, constraints, and programs in the Work Station.

2.11.2 Work Station/FEP

The Work Station shall be able to initiate an upload or download of FEP data and programs.

2.11.3 Workstation Network Access via Bridge

Workstation not directly connected to a remote LAN shall be able to communicate with the remote LANs using bridges as specified and shown.

2.11.4 Workstation Network Access via Network Security Call Back Modem

Workstation not directly connected to a LAN shall be able to communicate with remote LAN using the workstation modems and remote LAN security call back modems. All incoming calls shall be logged with time, day, date, duration and caller's identification. All callback connections shall be logged with time day, date, duration and caller's identity.

2.11.5 Workstation Modem Communication

Workstation shall be able to communicate with other computer systems using a modem and dialup circuit. Workstation shall be able to initiate upload or download of data files, however, the workstation shall not be able to answer any incoming calls (for system security reasons).

2.11.6 Error Detection and Retransmission

Asynchronous transmission system shall use cyclic code error detection methods which shall detect single and double bit errors, burst errors of eight bits or less, and at least 99% of other multibit and burst error conditions. Interactive or product error detection codes alone shall not be acceptable. A message shall be in error if one bit is received incorrectly. The system shall retransmit messages with detected errors. Where a LAN is not utilized for data transmission, a 2-digit decimal number shall be operator assignable to each communication link representing the number of retransmission attempts. When the number of consecutive retransmission attempts equals the assigned quantity, the Work Station

shall close down transmission to that particular device, and print an alarm message. The operator shall manually reopen any communications line after automatic closedown, subject to the same error checking and automatic closedown procedures in effect before the first automatic closedown. The system shall monitor the frequency of data transmission errors for display and logging. This may be accomplished by ancillary equipment or provided as an integral part of the primary system. LANs shall be provided with fault tolerance capabilities to isolate jabbering equipment, identify timeout errors, and identify lost data packets. The LANs shall operate under fault conditions until the trouble modes are either removed or fixed.

2.11.7 Automatic Backup Switching

The system shall support automatic switchover to a backup dial-up circuit as shown. The system shall perform the switchover when the number of successive failed attempts to communicate over an identified circuit reaches a number which shall be settable by the operator. The return of communications to the normal path shall be manually initiated by the operator. Upon switchover, the system shall generate an alarm message indicating that the switchover has taken place, with time of switchover annotated.

2.12 DTS

The Contractor shall provide DTS as shown between the Work Station and FEPs as specified in Section 16768A FIBER OPTIC DATA TRANSMISSION SYSTEM and Section 16792A WIRE LINE DATA TRANSMISSION SYSTEM.

2.13 FACTORY TEST

2.13.1 Factory Test Setup

The Contractor shall assemble and integrate the factory test setup as specified to prove that performance of the system satisfies all requirements of this project, including system communications requirements in accordance with the approved test procedures. The factory test shall take place during regular daytime working hours on weekdays. Model numbers of equipment demonstrated shall be identical to those to be delivered to the site. Original copies of data produced during the factory test, including results of each demonstration procedure, shall be delivered to the Government at the conclusion of the test, prior to Government approval of the factory test. The report shall be arranged so that commands, responses, and data acquired are correlated to allow logical interpretation of the data. Surge testing need not be conducted if the Contractor can provide acceptable documented proof that such testing has been satisfactorily demonstrated to the Government with identical surge protection applied. The factory test setup shall include the following:

- a. Work Station Equipment as specified.
- b. Workstations as specified.
- c. One Smart Field Panel per DTS type, but not less than two Smart Field Panels.
- d. One Unitary Controller of each type used in the proposed system.
- e. Test Set.

- f. Portable Tester/Workstation.
- g. Sufficient I/O functions to demonstrate the I/O capability and system normal operation.
- h. Communications circuits of each type and speed to be utilized in the proposed system including bridges, modems, encoder/decoders, transceivers, and repeaters as specified.
- i. Surge protection equipment for power, communications, I/O functions, and networks.
- j. Software required for proper operation of the proposed system including application programs and sequences of operation.

2.13.2 Factory Test Procedures Package

The Contractor shall deliver the approved factory test procedures package to the Government prior to or concurrent with written notification of the scheduled factory test. The package shall also include the following:

- a. Factory test equipment block diagram.
- b. Hardware descriptions.
- c. Software descriptions.
- d. Operator commands.
- e. I/O functions with failure modes for test database points.
- f. Required passwords for each operator access level.
- g. Description of each type of digital and analog point in the test database.
- h. List of test equipment.
- i. Surge protection circuit diagrams.
- j. Inputs required for each application program (I/O point values and status) and corresponding expected results of each set of input values.
- k. Default values for the application program inputs not implemented or provided for in the contract documents for the application programs to be tested.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

3.1.1 Installation

The Contractor shall install system components and appurtenances in accordance with the manufacturer's instructions and shall provide necessary interconnections, services, and adjustments required for a complete and operable system. Instrumentation and communication equipment and cable grounding shall be installed as necessary to preclude ground loops, noise,

and surges from adversely affecting system operation. The Contractor shall adjust or replace all devices not conforming to the required accuracies, except those which are factory set and sealed. These factory sealed devices shall be replaced (not adjusted). Wiring in exposed areas, including low voltage wiring, shall be installed in metallic raceways or EMT conduit as specified in SECTION 16415A ELECTRICAL WORK, INTERIOR. Wiring in air plenum areas installed without conduit shall be plenum-rated per NFPA 70. The existing controls shall remain in operation until the new UMCS panels are ready for cutover. The Contractor shall schedule and arrange the cutover of the new panels to cause the least disruption to the Government. This cutover activity shall be fully coordinated with the Government, and written permission shall be obtained by the Contractor before beginning this work.

3.1.1.1 Isolation, Penetrations of Buildings and Clearance from Equipment

The UMCS shall be completely installed and ready for operation, as specified and shown. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exteriors shall be made watertight. Holes in concrete, brick, steel and wood walls shall be drilled or core drilled with proper equipment; conduits installed through openings shall be sealed with materials which are compatible with existing materials. Openings shall be sealed with materials which meet the requirements of NFPA 70 and SECTION 07840A FIRESTOPPING. The UMCS installation shall provide clearance for control-system maintenance by maintaining access space between coils, access space to mixed-air plenums, and other access space required to calibrate, remove, repair, or replace control-system devices. The control-system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.1.2 Device Mounting

Devices mounted in or on piping, on building surfaces, in mechanical/electrical spaces, or in occupied space ceilings shall be installed in accordance with manufacturers' recommendations and as shown. Control devices to be installed in piping and ductwork shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified. Any deviations shall be documented by the Contractor and submitted to the Government for approval prior to mounting. Damaged insulation shall be replaced or repaired after devices are installed to match existing work. Damaged galvanized surfaces shall be repaired by touching up with zinc paint.

3.1.2 System Requirements

The Contractor shall use the diagrams, database tables and operating sequences in conjunction with other specified requirements to identify the hardware and software required.

3.1.3 Instrumentation and Control Diagrams

Framed, non-fading half-size drawings in laminated plastic shall be provided for equipment furnished and for interfaces to existing equipment at each respective equipment location. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the

system for normal safe operation, and procedures for safely starting and stopping the system manually shall be prepared in typed form, framed as specified for the diagrams and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting. The instructions shall be posted before PVT begins.

3.1.4 Sequences of Operation

The Contractor shall study the operation and sequence of existing controls, as a part of his existing conditions report, and note any deviations from the described sequences of operation on the contract drawings. The Contractor shall make necessary adjustments to make the equipment operate in an optimum manner, and shall fully document any required changes made. The Contractor shall coordinate the installation of all new equipment to insure continued operation of those items which are to remain.

3.2 INSTALLATION OF EQUIPMENT

The Contractor shall install equipment as specified, as shown and as required in the manufacturer's instructions for a complete and fully operational UMCS.

3.2.1 FEP

FEPs shall be installed in place of existing automatic temperature control panels and other control and monitoring equipment. Existing equipment not reused as part of the UMCS shall be removed and disposed as directed by the Government. Existing wiring, conduit and tubing that is not reused shall be removed. DTC shall serve as an interface between each FEP and the instrumentation and controls where shown. No instrumentation or control devices shall be located within the DTC.

3.2.2 Temperature Instrument Installation

3.2.2.1 RTD

When the RTD is installed in pipe or is susceptible to corrosion or vibration, the RTD shall be installed in a thermowell. Thermowells shall be filled with conductive heat transfer fluid prior to installation of the RTD in the thermowell. RTDs used for space temperature sensing shall include a housing suitable for wall mounting. RTDs used for OA sensing shall have an instrument shelter or sun shield as shown to minimize solar effects, and shall be mounted to minimize building effects. RTD assemblies shall be readily accessible and installed in a manner to allow easy replacement.

3.2.2.2 Temperature Switches

Temperature switches shall be installed as specified for RTDs. Temperature switches shall be adjusted to the proper setpoint and shall be verified by calibration. Switch contact ratings and duty shall be selected for the application.

3.2.2.3 Thermometers and Temperature Sensing Elements

Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells.

3.2.2.4 Instrument Shelters

Instrument shelters shall be installed in the location shown with the bottom 4 feet above the supporting surface using legs and secured rigidly to minimize vibrations from winds. Instrument shelters shall be oriented with door facing North. Instruments located in shelters shall be mounted in the 3-dimensional center of the open space of the shelter.

3.2.3 Relative Humidity Instrument

The relative humidity r.h. sensors shall have air guards when installed in air flows of more than 15 meters per second across the sensor element.

3.2.4 Room Instrument Mounting

Room instruments shall be installed in place of existing space thermostats and humidistats. Existing devices shall be removed and shall become the property of the Government. Where new instruments are required or room instruments are to be relocated, as shown, new room instruments shall be mounted so that their sensing elements are 5 feet above the finished floor unless otherwise shown. Where new room instruments do not completely cover the existing installation, or a room instrument is not installed in the space of a removed device, or the existing wall finish is damaged during construction work of this project, the Contractor shall patch, repair and paint as necessary to match the existing wall finish.

3.2.5 Level Instruments

3.2.5.1 Level Switches

Level switches shall be installed in accordance with the manufacturer's instructions. Switches shall be accessible for maintenance and calibration.

3.2.6 Electric Power Devices

3.2.6.1 Current Sensing Relays

When used to sense fan/pump status, current sensing relays shall be used for applications under 5 hp. Applications over 5 hp shall use a current transducer.

3.2.7 Position Sensors

3.2.7.1 End (Limit) Switch

Limit switch type and mounting shall be properly suited for the application to provide reliable switch operation. Switches shall be positioned to reliably sense the required position.

3.2.7.2 Damper End Switches

Damper end switches and mountings shall be properly suited for the application to provide reliable operation.

3.2.7.3 Potentiometers and Associated Transducers

Potentiometer type and mounting shall be properly suited for the application to provide reliable operation. Transducers shall be matched to the potentiometers type and range to provide a compatible 4 to 20 mA signal

to the FEP.

3.2.8 Output Devices

All output devices (transducers, relays, or other devices) not an integral part of the FEP shall be mounted in an enclosure mounted adjacent to the FEP, unless otherwise shown.

3.2.8.1 Relays and Contactors

The Contractor shall install relays and contactors in new enclosures. H-O-A switches and override switches shall be installed so that UMCS controls function through the automatic position and other controls work through the hand position. Safety and fire or life safety interlocks shall function through both hand and automatic switch positions.

3.2.8.2 EH Valve

The Contractor shall install EHs on hydraulic piping.

3.2.8.3 Controllers

The Contractor shall install controllers in new enclosures.

3.2.9 Miscellaneous Instruments

Miscellaneous instruments shall be installed in accordance with the manufacturer's inspections and as shown.

3.2.10 Enclosures

All enclosure penetrations shall be from the bottom of the enclosure, and shall be sealed to preclude entry of water using a silicone rubber sealant.

3.2.11 Transformers

Transformers for control voltages below 120 Vac shall be fed from the nearest power panel or motor control center, using circuits provided for the purpose. The Contractor shall provide a disconnect switch on the primary side and a fuse on the secondary side. Transformers shall be enclosed in a steel cabinet with conduit connections.

3.2.12 Wire and Cable Installation

System components and appurtenances shall be installed in accordance with NFPA 70, manufacturer's instructions and as shown. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system shall be provided. Components shall be labeled in accordance with EIA ANSI/TIA/EIA-606A. Penetrations in fire-rated construction shall be firestopped in accordance with Section 07840A FIRESTOPPING. Conduits, outlets and raceways shall be installed in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Wiring shall be installed in accordance with EIA ANSI/TIA/EIA-568-A and as specified in Section 16415A ELECTRICAL WORK, INTERIOR. Wiring, and terminal blocks and outlets shall be marked in accordance with EIA ANSI/TIA/EIA-606A. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables. Cables not installed in conduit or wireways shall be properly secured and neat in appearance.

3.2.12.1 Horizontal Distribution Cable

The rated cable pulling tension shall not be exceeded. Cable shall not be stressed such that twisting, stretching or kinking occurs. Cable shall not be spliced. Fiber optic cables shall be installed in either conduit or through type cable trays to prevent microbending losses. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided. Cables shall be terminated; no cable shall contain unterminated elements. Minimum bending radius shall not be exceeded during installation or once installed. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered.

3.2.12.2 Riser and Backbone Cable

Vertical cable support intervals shall be in accordance with manufacturer's recommendations. Cable bend radius shall not be less than ten times the outside diameter of the cable during installation and once installed. Maximum tensile strength rating of the cable shall not be exceeded. Cable shall not be spliced.

3.2.12.3 Telecommunication Outlets

- a. Faceplates: As a minimum each jack shall be labeled as to its function and a unique number to identify cable link.
- b. Cables: Unshielded twisted pair and fiber optic cables shall have a minimum of 6 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturers bend radius for each type of cable shall not be exceeded.
- c. Special Cable Tagging Requirements: Cables installed inside buildings shall be tagged at 10 foot intervals prior to installation.
- d. Pull Cords: Pull cords shall be installed in all conduit serving telecommunications outlets which do not initially have fiber optic cable installed.
- e. Terminal Blocks: Terminal blocks shall be mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Industry standard wire routing guides shall be utilized.

3.2.12.4 Unshielded Twisted Pair Patch Panels

Patch panels shall be mounted in equipment racks with sufficient modular jacks to accommodate the installed cable plant plus 10 percent spares. Cable guides shall be provided above, below and between each panel.

3.2.12.5 Fiber Optic Patch Panels

Patch panels shall be mounted in equipment racks with sufficient ports to accommodate the installed cable plant plus 10 percent spares. A slack loop of fiber shall be provided within each panel. Loop shall be 3 feet in length. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel,

using clamps or brackets specifically manufactured for that purpose.

3.2.12.6 Equipment Racks

Open frame equipment racks shall be bolted to the floor. Cable guides shall be bolted or screwed to racks. Racks shall be installed level. Ganged racks shall be bolted together. Ganged rack cabinets shall have adjacent side panels removed. Wall mounted racks shall be secured to the mounting surfaces to prevent fully loaded racks from separating from the mounting surface.

3.2.12.7 Rack Mounted Equipment

Equipment to be rack mounted shall be securely fastened to racks by means of the manufacturers recommended fasteners.

3.2.13 TERMINATION

Cables and conductors shall sweep into termination areas; cables and conductors shall not bend at right angles. Manufacturer's minimum bending radius shall not be exceeded. When there are multiple system type drops to individual workstations, relative position for each system shall be maintained on each system termination block or patch panel.

3.2.13.1 Unshielded Twisted Pair Cable

Each pair shall be terminated on appropriate outlets, terminal blocks or patch panels. No cable shall be unterminated or contain unterminated elements. Pairs shall remain twisted together to within the proper distance from the termination as specified in EIA ANSI/TIA/EIA-568-A. Conductors shall not be damaged when removing insulation. Wire insulation shall not be damaged when removing outer jacket.

3.2.13.2 Shielded Twisted Pair Cables

Each cable shall be terminated on panel-mounted connectors. Cables shall be grounded at patch panels using manufacturer's recommended methods. Shield braid shall be continuous to connector braid terminator. Wire insulation shall not be damaged when removing shield.

3.2.13.3 Coaxial Cable

Home run type station cables shall be terminated at each end. Backbone cables shall be terminated with appropriate connectors or end-of-line terminators as required. Loop-type cable systems shall be terminated with appropriate drop connectors and terminators as required. Backbone cable shield conductor shall be grounded to communications ground at only one point and shall not make electrical contact with ground anywhere else.

3.2.13.4 Fiber Optic Cable

Each fiber shall have connectors installed. The pull strength between the connector and the attached fiber shall not be less than 25 pounds. The mated pair loss, without rotational optimization, shall not exceed 1.0 db. Fiber optic connectors shall be installed per EIA ANSI/TIA/EIA-568-A.

3.2.14 Grounding

Signal distribution system ground shall be installed in the

telecommunications entrance facility and in each telecommunications closet in accordance with EIA ANSI/TIA/EIA-607A and Section 16415A ELECTRICAL WORK, INTERIOR. Equipment racks shall be connected to the electrical safety ground.

3.3 SOFTWARE INSTALLATION

The Contractor shall load software required for an operational UMCS, including databases (for points specified and shown), operational parameters, and system, command, and application programs. The Contractor shall adjust, tune, debug, and commission all software and parameters for controlled systems to assure proper operation in accordance with the sequences of operation and database tables.

3.4 SITE TESTING

The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The Government will witness the PVT, and written permission shall be obtained from the Government before proceeding with each phase of testing. Original copies of data produced, including results of each test procedure, during PVT shall be turned over to the Government at the conclusion of each phase of testing prior to Government approval of the test. The PVT shall not be run during scheduled seasonal off-periods of heating and cooling systems. Testing shall be performed in accordance with approved test procedures developed using MIL-STD-2203, as a technical and format requirement. The Test Procedures shall cover actual equipment and functions specified from the project. Additional test procedures for any operational modes or equipment which are not specifically addressed in the MIL-STD shall be prepared by the Contractor, using the same methodology and format as is required by the MIL-STD.

3.4.1 Testing, Adjusting and Commissioning

After the Contractor has received written approval of the Group I data package and after successful completion of the Factory Test as specified, the Contractor will be authorized to proceed with the installation of the system equipment, hardware, and software. Once the installation has been completed, the Contractor shall test, adjust, and commission each control loop and system and shall verify proper operation of each item in the sequences of operation, including hardware and software. The Contractor shall calibrate field equipment, including control devices, adjust control parameters and logic (virtual) points including control loop setpoints, gain constants, constraints, and verify data communications before the system is placed online. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. The Contractor shall calibrate each instrumentation device connected to the UMCS control network by making a comparison between the reading at the device and the display at the Workstation, using a standard at least twice as accurate as the device to be calibrated. The Contractor shall check each control point within the UMCS control network by making a comparison between the control command at the Workstation and field-controlled device.

The Contractor shall deliver trend logs/graphs of all points showing to the Government that stable control has been achieved. Points on common systems shall be trended simultaneously. One log shall be provided showing concurrent samples taken once a minute for a total of 4 hours. One log shall be provided showing concurrent samples taken once every 30 minutes, for a total of 24 hours. The Contractor shall verify operation of systems in the specified failure modes upon UMCS network failure or loss of power,

and verify that systems return to UMCS control automatically upon a resumption of UMCS network operation or return of power. The Contractor shall deliver a report describing results of functional tests, diagnostics, calibrations and commissioning procedures including written certification to the Government that the installed complete system has been calibrated, tested, adjusted and commissioned and is ready to begin the PVT. The report shall also include a copy of the approved PVT Procedure.

3.4.2 PVT

The Contractor shall demonstrate that the completed UMCS complies with the contract requirements. Using approved test procedures, based on using MIL-STD-2203 as a technical and format requirement, all physical and functional requirements of the project including communication requirements shall be demonstrated and shown. The Contractor shall demonstrate that each system operates as required in the sequence of operation. The PVT as specified shall not be started until after receipt by the Contractor of written permission by the Government, based on the Contractor's written report including certification of successful completion of Testing, Adjusting and Commissioning as specified, and upon successful completion of training as specified. Upon successful completion of the PVT, the Contractor shall deliver test reports and other documentation as specified to the Government.

3.4.3 Endurance Test

The Contractor shall use the endurance test as specified to demonstrate the specified overall system reliability requirement of the completed system. The endurance test shall be conducted in phases as specified. The endurance test shall not be started until the Government notifies the Contractor in writing that the PVT is satisfactorily completed, training as specified has been completed, outstanding deficiencies have been satisfactorily corrected, and that the Contractor has permission to start the endurance test. The Contractor shall provide an operator to man the system 8 hours per day during daytime operations, including weekends and holidays, during Phase I and Phase III endurance testing, in addition to any Government personnel that may be made available. The Government may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to acceptance of the system.

3.4.3.1 Phase I (Testing)

The test shall be conducted 24 hours per day, 7 days per week, for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing. If the system experiences no failures during the Phase I test, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.

3.4.3.2 Phase II (Assessment)

After the conclusion of Phase I, the Contractor shall identify failures, determine causes of failures, repair failures, and deliver a written report to the Government. The report shall explain in detail the nature of each

failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Government. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, the Contractor shall demonstrate that failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the Government will determine the restart point, and may require that the Phase I test be totally or partially rerun. The Contractor shall not commence any required retesting until after receipt of written notification by the Government. After the conclusion of any retesting which the Government may require, the Phase II assessment shall be repeated as if Phase I had just been completed. If the retest is completed without any failures, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.

3.4.3.3 Phase III (Testing)

The test shall be conducted 24 hours per day, 7 days per week, for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing.

3.4.3.4 Phase IV (Assessment)

After the conclusion of Phase III, the Contractor shall identify failures, determine causes of failures, repair failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed, if any deficiencies appeared during Phase III. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Government. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, the Contractor shall demonstrate that failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and test review meeting, the Government may require that the Phase III test be totally or partially rerun. The Contractor shall not commence any required retesting until after receipt of written notification by the Government. After the conclusion of any retesting which the Government may require, the Phase IV assessment shall be repeated as if Phase III had just been completed.

3.4.3.5 Exclusions

The Contractor will not be held responsible for failures resulting from the following:

- a. An outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the UMCS performed as specified.
- b. Failure of a Government furnished communications link, provided that the FEP automatically and correctly operates in the stand-alone mode as specified, and that the failure was not due to

Contractor furnished equipment, installation, or software.

- c. Failure of existing Government owned equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

3.5 TESTING WIRE AND CABLE

Materials and documentation to be furnished under this specification are subject to inspections and tests. All components shall be terminated prior to testing. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided.

3.5.1 Unshielded Twisted Pair Tests

All metallic cable parts shall be tested for proper identification and continuity. All opens, shorts, crosses, grounds, and reversals shall be corrected. Correct color coding and termination of each pair shall be verified in the communications closet and at the outlet. Horizontal wiring shall be tested from and including the termination device in the communications closet to and including the modular jack in each room. Backbone wiring shall be tested end-to-end, including termination devices, from terminal block to terminal block, in the respective communications closets. These test shall be completed and all errors corrected before any other tests are started.

3.5.2 Category 3 and Category 5 Circuits

Twenty five percent of the installed Category 3 circuits, selected on a random basis, and all Category 5 circuits shall be tested using a test set that meets the Class II accuracy requirements of EIA TIA/EIA-TSB-67. Testing shall use the Basic Link Test procedure of EIA TIA/EIA-TSB-67. If more than 5 percent of the Category 3 circuits tested fail, then all Category 3 circuits shall be tested. Cables which contain failed circuits shall be replaced and retested to verify the standard is met.

3.5.3 Shielded Twisted Pair

Wiring configuration shall be tested for continuity, opens, shorts, swaps and correct pin configuration; dc resistance both pair-to-pair and wire-to-shield shall be verified. Cable lengths shall be verified. Near end crosstalk shall be tested from 722 kHz to 300 MHz. Ground potential difference between wiring closets, ground path resistance shall be tested per IBM GA27-3361-07.

3.5.4 Coaxial Cable

Cable shall be tested for continuity, shorts, and opens. Characteristics impedance shall be verified over the range of intended operation. Cable length shall be verified. Cable shall be sweep tested for attenuating over the range of intended operation.

3.5.5 Fiber Optic Cable

Unless stated otherwise, tests shall be performed from both ends of each circuit. Connectors shall be visually inspected for scratches, pits, or chips and shall be reterminated if any of these conditions exist. Each

circuit leg and complete circuit shall be tested for insertion loss at 850 and 1300 nm using a light source similar to that used for the intended communications equipment. High-resolution optical time domain reflectometer (OTDR) test shall be performed from one end of each fiber. Scale of the OTDR trace shall be such that the entire circuit appears over a minimum of 80 percent of the X-axis.

3.6 RELIABILITY CALCULATION

This exponential calculation depends on the test duration and assumes that the Mean Time Between Failures (MTBF) does not change after each repair; and that the probability of failure is constant throughout the useful life of the component regardless of how many failures the system has experienced. This calculation does not account for effects of aging.

3.6.1 Definition of Reliability

System reliability is calculated in terms of overall MTBF where the component reliability furnished by vendors is already expressed as MTBF. The mathematical combination of the component MTBF values is defined as the system reliability, $R(t)$; the probability that the system will perform its function during a given time period under specified conditions. In this calculation, each component reliability is determined; the component reliabilities are combined as dictated by the system configuration; and the overall MTBF is computed as follows:

$$R(t) = e^{-t/MTBF}; \text{ where:}$$

MTBF = mean time between failure

t = duration of test period

e = base of natural logarithms

When $t/MTBF$ is less than 0.1, the reliability can be approximated as follows:

$$R(t) = 1 - (t/MTBF)$$

A specific reliability value can be interpreted by noting that a value of $R(t)$ greater than $1/e$ (which equals 0.37) indicates that the MTBF value is greater than the test duration.

3.6.2 Series and Parallel Components

Components are in series if failure of one component causes a system failure. Reliability of components in series is a product of the individual reliabilities:

$$R = 1 - (r_1)(r_2)(r_3) \dots (r_n)$$

If components in a system are redundant (parallel), reliability is computed as follows:

$$R = 1 - \{ (1-r_1)(1-r_2) \dots (1-r_n) \}$$

If a system has parallel components, an equivalent series reliability is computed for each set of parallel components. The reliability of the system is then computed as the product of series and equivalent series

reliabilities.

3.6.3 Calculation Procedure

The Contractor shall prepare a table showing the following data:

- a. Name and quantity of each component.
- b. Identify each component as series or parallel. (For example, if there are 2 printers, the failure of 1 will not cause a system failure).
- c. MTBF for each component.
- d. Single unit reliability: $R = e(-t/MTBF)$, where $t = 1,000$ hour test period.
- e. Total Component Reliability (TCR) where $TCR = R^n$, and n = number of components. For parallel components, $TCR = 1 - (1-R)^n$, where n = number of components.
- f. Cumulative Reliability (CUMR) is the product of total component reliability; for example:

$$CUMR\ 4 = (TCR1) (TCR2) (TCR3) (TCR4) = (CUMR3) (TCR4)$$
- g. Cumulative MTBF = $-1,000/LN (CUMR)$; where $LN (CUMR)$ is the natural logarithm of (CUMR).

As an example: $CUM.MTBF = -1,000/LN (CUMR4)$

3.6.4 Sample Calculations

MTBF is not calculated for sensors and controls. I/O functions are part of the FEP. Any I/O failure not attributable to sensors and controls constitutes an FEP failure and is thus reflected in the FEP MTBF. MTBF for other components are based on the lowest values provided by vendors. The MTBF of a Workstation is assumed to be 16,000 hours. The numbers of components for the UMCS Work Station configuration are as follows:

Workstation	1
Network LAN Equipment - one of each	1
Network Security Call Back Modem	1
Smart Field Panel	3
Unitary Controller	1
I/O Functions	64

-- End of Section --

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus

1.2 RELATED REQUIREMENTS

This section applies to all sections of Division 15, "Mechanical" of this project specification, unless specified otherwise in the individual section.

1.3 QUALITY ASSURANCE

1.3.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.2 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.3 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.4 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a

conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.3.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors shall conform to and have electrical connections provided under Section 16415A, "Electrical Work, Interior." Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Unless indicated otherwise, controllers and contactors shall have a maximum of 120 volt control circuits, and shall have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work shall be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements of other sections of this specification.

1.6 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.7 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B 117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

3.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

- a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.
- b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.
- c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

-- End of Section --

SECTION 15070

MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 575 (1994) Measuring Machinery Sound Within an Equipment Space

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M (1997) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM D 471 (1996) Rubber Property - Effect of Liquids

ASTM D 2240 (1997) Rubber Property - Durometer Hardness

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (1998) Structural Welding Code - Steel

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA HVAC Duct Const Stds (1985) HVAC Duct Construction Standards - Metal and Flexible

1.2 RELATED REQUIREMENTS

The provisions of Section 15050N, "Basic Mechanical Materials and Methods", apply to this section.

1.3 DEFINITIONS

1.3.1 Decibels dB

Measure of sound level. Decibels are referenced to either 20 uPa for sound pressure levels or one pW for sound power levels. dBA is the overall "A" weighted sound level.

1.3.2 Machinery

The vibration or noise producing equipment that must be isolated.

1.3.3 Manufacturer

The fabricator or supplier of vibration-isolation or seismic-protection materials and equipment. For mechanical equipment and machinery the term machinery manufacturer will be used.

1.3.4 Micropascal uPa

10 to the minus 6 power newtons per square meter.

1.3.5 Picowatt pW

10 to the minus 12 power watts.

1.4 SYSTEM DESCRIPTION

1.4.1 Spring Isolator Data

For each type and size of spring isolator, submit the spring outside diameter, deflection, operating spring height, unloaded spring height, solid spring height, the ratio of the outside diameter to the operating spring height, the load to deflection ratio of the springs, and weight and sizes of structural steel members.

1.4.2 Machinery Manufacturer's Sound Data

For each piece of indicated machinery to be vibration isolated, the calculated sound power test data or sound pressure test data as levels in dB in the eight octave bands between 63 and 8,000 Hz. Refer sound power levels to one pW and sound pressure levels to 20 uPa. Submit the overall "A" weighted scale sound pressure level in dB. Submit the standard test procedure used to obtain the sound power or pressure data for the applicable vibration isolation equipment size.

1.4.3 Machinery

For each item of machinery, compare spring static deflections with the specified minimum static deflection, to show that the calculated spring static deflections are not less than the minimum static deflections specified. Rated spring static deflections are not acceptable in lieu of calculated spring static deflections.

1.4.4 Machinery Over 300 Pounds

For machinery items over 300 pounds, provide calculations for shear, pull-up, primary overturning, and secondary overturning.

1.4.5 Machinery Vibration Criteria

TABLE 1A

Class II Vibration Isolator Types and Minimum Static Deflection
(MSD, inches)

<u>Equipment</u>	<u>Type (Note (1))</u>	<u>MSD</u>
Factory Assembled Air Handling Equipment AH, AC and HV Units		

TABLE 1A

Class II Vibration Isolator Types and Minimum Static Deflection
(MSD, inches)

<u>Equipment</u> (Note (2))	<u>Type (Note (1))</u>	<u>MSD</u>
Suspended Units		
Up to 5 hp	H	1.0
Over 5 hp		
Up to 400 rpm	H	1.75
Over 401 rpm	H	1.0
Floor Mounted Units		
Up to 5 hp	NP	0.25
	NM	0.35
Over 5 hp		
Up to 400 rpm	NM	0.35
Over 401 rpm	NM	0.35

NOTES: Note (1) and Note (2) are same as for TABLE 1A.

NOTES: (1) Equipment Vibration Isolation Schedule Designations
(Hyphenated designations are combinations of the following:)

B - Welded structural steel bases.

H - Spring isolators (suspended equipment and piping). Where required, provide with adjustable preloading devices.

HR - Thrust restraints

I - Concrete inertia bases with steel forms.

NM - Neoprene mounts.

NP - Neoprene pads.

R - Structural steel rail for equipment mounts.

S - Freestanding spring isolators (floor-mounted equipment).

SV - Freestanding spring isolators (floor-mounted equipment).

SX - Freestanding spring isolators with adjustable cushioned vertical stops and cushioned horizontal stops (floor-mounted equipment). Protected spring isolators SX may be substituted wherever S or SV is specified and shall meet all requirements.

(2) Fans

- a. When fan motors are 75 hp or larger, use the deflection requirements for the next wider column spacing. Except

TABLE 1A

Class II Vibration Isolator Types and Minimum Static Deflection
(MSD, inches)

<u>Equipment</u>	<u>Type (Note (1))</u>	<u>MSD</u>
		for building slab on grade a minimum of 2.5 inches should be used unless larger deflections are specified in the centrifugal blower table.
b.	Provide sway brace isolators for tubular centrifugal and axial fans when the fan pressure exceeds 4 inches water column.	
c.	Provide inertia bases for all fans in lieu of structural steel bases or rails specified above when the fan pressure exceeds 4 inches water column.	
d.	With attaching brackets, suspension spring isolators bridge between the structure and the thrust-producing machinery such as high-pressure fan. Both types H and HR normally provide reaction in tension, while types S, SV, and SX normally provide reaction in compression. Thrust restraints are low-cost and effective components available from manufacturers. Use thrust restraints to eliminate the need for or reduce the magnitude of inertia mass when the mass is only used to reduce the displacement effects of the thrust.	

Provide vibration isolators for mechanical and electrical machinery to minimize transmission of vibrations and structure borne noise to the building structure or spaces or from the building structure to the machinery. Comply with the following vibration schedule.

1.4.6 Machinery Airborne Sound Level Criteria

TABLE 2A
Sound Data Schedule

<u>Equipment</u>	<u>Maximum Sound Power Level (dB)</u>							
	<u>Octave Band Level Center Frequency (Hz)</u>							
	63	125	250	500	1000	2000	4000	8000
Air Handling Unit	94	90	89	89	89	84	82	79
Air Conditioning Unit	100	96	90	89	86	80	75	72
Fan	55	50	48	47	48	46	42	37

1.4.6.1 Basic Criteria

For each piece of machinery in the human work environment, do not exceed the maximum airborne sound levels 84 dB A-weighted scale, continuous or intermittent, or 140 dB peak sound pressure-level, impact or impulse, noise.

1.4.7 Welding

AWS D1.1/D1.1M.

1.5 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-03 Product Data

Isolators

Flexible connectors

Flexible duct connectors

Machinery manufacturer's sound data

SD-08 Manufacturer's Instructions

Vibration and noise isolation components

1.6 QUALITY ASSURANCE

1.6.1 Vibration Isolator Procurement

For each piece of machinery to be isolated from vibration, supply the vibration isolators, and other associated materials and equipment as a coordinated package by a single manufacturer or by the machinery manufacturer. Select isolators that provide uniform deflection even when machinery weight is not evenly distributed. This requirement does not include the flexible connectors or the hangers for the associated piping and ductwork.

1.6.2 Unitized Machinery Assemblies

Mounting of unitized assemblies directly on vibration isolation springs is acceptable if machinery manufacturer certifies that the end supports of the assemblies have been designed for such installation.

PART 2 PRODUCTS

2.1 CORROSION PROTECTION FOR STEEL PARTS

ASTM A 123/A 123M hot-dipped galvanized, or equivalent manufacturer standard coatings. Where steel parts are exposed to the weather, provide galvanized coating of at least 2 ounces of zinc per square foot of surface. Coat springs with neoprene.

2.2 NEOPRENE

ASTM D 471 and ASTM D 2240, Grade Durometer 40, 50, or 60, and oil resistant.

2.3 FLOOR-MOUNTED ISOLATORS

2.3.1 Neoprene Isolation Pads

Provide pads at least 1/4 inch thick with cross-ribbed or waffle design. For concentrated loads, provide steel bearing plates bonded or cold cemented to the pads.

2.3.2 Neoprene Isolators

Provide molded neoprene isolators having steel base plates with mounting holes and, at the top, steel mounting plates with mounting holes or threaded inserts. Provide elements of type and size coded with molded letters or color-coded for capacity identification. Embed metal parts completely in neoprene.

2.4 SPRING ISOLATORS AND PROTECTED SPRING ISOLATORS

Provide spring isolators or protected spring isolators that are adjustable and laterally stable with free-standing springs of horizontal stiffness at minimum 80 percent of the vertical (axial) stiffness. For machine-attached and floor-attached restraining elements, separate from metal-to-metal contact by neoprene cushions 1/8 inch thick minimum. Provide neoprene acoustic friction pads at least 1/4 inch thick.

2.4.1 Springs

Provide springs with base and compression plates, to keep spring ends parallel during and after deflection to operating height. Provide outside coil diameters at least 0.8 of the operating height. At operating height, springs shall have additional travel to complete (solid) compression equal to at least 50 percent of the operating deflection.

2.4.2 Mounting and Adjustment

Provide base and compression plates with mounting holes or threaded fittings. Bolt leveling adjustment bolts to machinery or base.

2.5 SUSPENSION ISOLATORS

Provide hangers with suspension isolators encased in open steel brackets. Isolate hanger rods from isolator steel brackets with neoprene-lined opening.

2.5.1 Suspension Neoprene Isolators

Provide double-deflection elements with minimum 3/8 inch deflection.

2.5.2 Suspension Spring Isolators

Provide hangers with springs and molded neoprene elements in series. Provide isolators with adjustable spring-preloading devices where required to maintain constant pipe elevations during installation and when pipe operational loads are transferred to the springs.

2.6 FLEXIBLE DUCT CONNECTORS

Provide flexible duct connectors fabricated in accordance with SMACNA HVAC Duct Const Stds.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Vibration and Noise Isolation Components

Install vibration-and-noise isolation materials and equipment in accordance with machinery manufacturer's instructions.

3.1.2 Suspension Vibration Isolators

Provide suspension isolation hangers for piping, suspended equipment, and suspended equipment platforms in mechanical equipment rooms, and as specified. For operating load static deflections of 1/4 inch or less, provide neoprene pads or single deflection neoprene isolators. For operating load static deflections over 5/16 to 3/8 inch, provide double-deflection neoprene element isolators. For operating load static deflections over 3/8 inch, provide isolators with spring and neoprene elements in series.

3.1.3 Vertical Stops

For machinery affected by wind pressure or having an operational weight different from installed weight, provide resilient vertical limit stops which prevent spring extension when weight is removed. Provide vertical stops for machinery containing liquid, such as water chillers, evaporative coolers, boilers, and cooling towers. Spring isolated or protected spring isolated machinery must rock and move freely within limits of stops or seismic restraint devices.

3.1.4 Thrust Restraints

Where required, provide pairs of thrust restraints, symmetrically installed on both sides of the steady state line of thrust.

3.1.5 Flexible Duct Connectors

Install flexible connectors in accordance with the manufacturer's instructions.

3.1.6 Machinery

Provide vibration isolators, flexible connectors in accordance with manufacturer's recommendations. Machinery with spring isolators or protected spring isolators shall rock or move freely within limits of stops.

3.1.6.1 Stability

Isolators shall be stable during starting and stopping of machinery without traverse and eccentric movement of machinery that would damage or adversely affect the machinery or attachments.

3.1.6.2 Lateral Motion

The installed vibration isolation system for each piece of floor or ceiling mounted machinery shall have a maximum lateral motion under machinery start up and shut down conditions of not more than 1/4 inch. Restrain motions in excess by approved spring mountings.

3.1.6.3 Unbalanced Machinery

Provide foundation suspension systems specifically designed to resist horizontal forces for machinery with large unbalanced horizontal forces. Vibration isolator systems shall conform to the machinery manufacturer's recommendations.

3.1.6.4 Nonrotating Machinery

Mount nonrotating machinery in systems which includes rotating or vibrating machinery on isolators having the same deflection as the hangers and supports for the pipe connected to.

3.1.7 High Pressure Ductwork Hanger and Support Installation

3.1.7.1 Duct Anchors

Attach each end of the duct anchor to an omni-directional isolator which in turn shall be rigidly fastened to the steel framing or structural concrete.

Vertical restraints shall be provided by similar material arranged to prevent vertical travel in either direction. The load on the isolation material shall not exceed 500 psi.

3.1.8 Machinery Foundations and Subbases

Provide anchor bolts as recommended by the machinery manufacturer.

3.1.8.1 Common Machinery Foundations

Mount electrical motors on the same foundations as driven machinery.

3.1.8.2 Anchor Bolts and Grout

Secure machinery to foundations and inertia bases with anchor bolts. Grout equipment with baseplates, the full area under baseplates with premixed non-shrinking grout. After grout has set, remove wedges, shims, and jack bolts and fill spaces with grout.

3.1.9 Electrical Connections

Provide flexible conduit or multiple conductor cable connections for machinery with sufficient extra length to permit 2 inch minimum displacement in any direction without damage.

3.2 FIELD QUALITY CONTROL

Provide equipment and apparatus required for performing inspections and tests. Notify Contracting Officer 14 days prior to machinery sound or vibration testing. Rebalance, adjust, or replace machinery with noise or vibration levels in excess of those given in the machinery specifications, or machinery manufacturer's data.

3.2.1 Field Inspections

Prior to initial operation, inspect the vibration isolators for conformance to drawings, specifications, and manufacturer's data and instructions. Check for vibration and noise transmission through connections, ductwork, and walls. Check connector alignment before and after filling of system

and during operation. Correct misalignment without damage to connector and in accordance with manufacturer's recommendations.

3.2.2 Spring Isolator Inspection

After installation of spring isolators or protected spring isolators, and seismic restraint devices, the machinery shall rock freely on its spring isolators within limits of stops or seismic restraint devices. Eliminate or correct interferences.

3.2.3 Tests

Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

3.2.3.1 Equipment Vibration Tests

Perform vibration tests to determine conformance with vibration isolation schedule specified.

3.2.3.2 Equipment Sound Level Tests

Measure continuous or intermittent steady state noise with a sound level meter set for low response. Measure impact or impulse noise as dB peak sound pressure level (20 uPa) with an impact noise analyzer. Measure work distance from person to machinery noise center. Perform sound level tests to determine conformance with sound level schedule specified.

a. Interior Machinery Sound

In accordance with ARI 575, measure the sound data for air conditioning and refrigeration machinery, such as fans, boilers, valves, engines, turbines, or transformers. Measure the sound pressure levels around mechanical and electrical machinery located in equipment spaces, 3 feet horizontally from the edge closest to the acoustical center of the machinery at points 3 feet and 5.5 feet above floor. Take measurements at the center of each side of the machinery. Locate the microphone at least 3 feet from the observer and measuring instruments. Observer shall not be between the machinery and the measuring instrument.

-- End of Section --

SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1126	(2000) Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM C 1136	(1995) Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 534	(2001a) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 665	(2001e1) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C 795	(1992; R 1998e1) Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C 920	(2002) Elastomeric Joint Sealants
ASTM C 921	(1989; R 1996) Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM D 882	(1997) Tensile Properties of Thin Plastic Sheeting
ASTM E 84	(2001) Surface Burning Characteristics of Building Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
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MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(1999) National Commercial & Industrial
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Insulation Standards

1.2 SYSTEM DESCRIPTION

Field-applied insulation and accessories on mechanical systems shall be as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated.

1.3 GENERAL QUALITY CONTROL

1.3.1 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.3.2 Installer's Qualifications

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.3.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Insulation systems which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Insulation materials located exterior to the building perimeter are not required to be fire-rated. Flame spread, and smoke developed indexes, shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

1.3.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.

SD-03 Product Data

General Materials; G

A complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value,

thickness and furnished accessories for each mechanical system requiring insulation shall be included. Materials furnished under this section of the specification shall be submitted at one time.

1.5 STORAGE

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means.

PART 2 PRODUCTS

2.1 GENERAL MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

2.1.1 Contact Adhesive

Adhesives may be dispersed in a volatile organic solvent. Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in the dry state in accordance with ASTM E 84. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The dried adhesive shall be nonflammable and fire resistant. Natural cross-ventilation, local (mechanical) pickup, and/or general area (mechanical) ventilation shall be used to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices.

2.1.2 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.1.3 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E 84. Tape shall be 4 inch wide rolls.

2.1.4 Staples

Outward clinching type monel. Monel is a nickel rich alloy that has high strength, high ductility, and excellent resistance to corrosion.

2.1.5 Jackets

ASTM C 921, Type I, maximum moisture vapor transmission 0.02 perms, (measured before factory application or installation), minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pounds/inch width. ASTM C 921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pounds/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials that require factory applied jackets are mineral fiber, cellular glass, and phenolic foam. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84.

2.1.5.1 White Vapor Retarder All Service Jacket (ASJ)

For use on hot/cold pipes, ducts, or equipment vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

2.1.6 Vapor Retarder Required

2.1.6.1 Laminated Film Vapor Retarder

ASTM C 1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.6.2 Polyvinylidene Chloride (PVDC) Film Vapor Retarder

The PVDC film vapor retarder shall have a maximum moisture vapor transmission of 0.02 perms, minimum puncture resistance of 150 Beach units, a minimum tensile strength in any direction of 30 lb/inch when tested per ASTM D 882, and a maximum flame spread/smoke developed index of 25/50 per ASTM E 84.

2.1.6.3 Polyvinylidene Chloride Vapor Retarder Adhesive Tape

Requirements must meet the same as specified for PVDC Film Vapor Retarder in paragraph 2.1.9.2 above.

2.1.7 Vapor Retarder Not Required

ASTM C 1136, Type III, maximum moisture vapor transmission 0.10 perms, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.8 Sealants

Sealants shall be chosen from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Sealants shall have a maximum moisture vapor transmission of 0.02 perms, and a maximum flame spread/smoke developed index of 25/50 per ASTM E 84.

2.2 PIPE INSULATION MATERIALS

Pipe insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.2.1 Aboveground Cold Pipeline

Insulation for minus 30 degrees to plus 60 degrees F for indoor exposed applications, shall be as follows:

- a. Flexible Elastomeric Cellular Insulation: ASTM C 534, Type I or II. Type II shall have vapor retarder skin on both sides of the insulation.
- b. Phenolic Insulation: ASTM C 1126, Type III. Phenolic insulations shall comply with ASTM C 795 and with the ASTM C 665 paragraph Corrosiveness. Supply the insulation with manufacturer's recommended factory-applied jacket.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after a one hour period; any insulation found to pull apart after one hour, shall be replaced.

3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds plates except where modified herein or on the drawings.

3.1.2 Installation of Flexible Elastomeric Cellular Insulation

Flexible elastomeric cellular insulation shall be installed with seams and joints sealed with rubberized contact adhesive. Insulation with pre-applied adhesive is not permitted. Flexible elastomeric cellular insulation shall not be used on surfaces greater than 200 degrees F. Seams shall be staggered when applying multiple layers of insulation. A brush coating of adhesive shall be applied to both butt ends to be joined and to both slit surfaces to be sealed. The adhesive shall be allowed to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of

being pulled apart one hour after application. Insulation that can be pulled apart one hour after installation shall be replaced.

3.1.3 Pipes/Ducts/Equipment which Require Insulation

Insulation is required on refrigerant piping.

3.2 PIPE INSULATION INSTALLATION

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used.

3.2.1.2 Pipes Passing Through Hangers

- a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed.
- b. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall conform to ASTM C 1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.3 Flexible Elastomeric Cellular Pipe Insulation

Flexible elastomeric cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

3.2.2 Aboveground Cold Pipelines

The following cold pipelines shall be insulated per Table I minus 30 degrees to plus 60 degrees F:

- a. Refrigerant suction lines.

3.2.2.1 Insulation Thickness

Insulation thickness for cold pipelines shall be determined using Table I.

Table I - Cold Piping Insulation Thickness
Pipe Size (inches)

Type of Service	Material	1 in & less
Refrigerant suction piping	FC	1.0
	PF	1.5

*Insulations may not be applied if their flame and smoke developed ratings exceed the requirements of 25/50 established in this guide specification.

LEGEND:

PF - Phenolic Foam

FC - Flexible Elastomeric Cellular

3.2.2.2 Jacket for Phenolic Foam

Insulation shall be covered with a factory applied vapor retarder jacket or field applied seal welded PVC jacket.

3.2.2.3 Insulation for Straight Runs Phenolic Foam

- a. Insulation shall be applied to the pipe with joints tightly butted. All butted joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating or PVDC adhesive tape.
- b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.
- c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. If staples are used, they shall be sealed per item "e." below. Note that staples are not required with cellular glass systems.
- d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.
- e. All Staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor retarder coating or PVDC adhesive tape. All seams, except those on factory self-seal systems shall be coated with vapor retarder coating or PVDC adhesive tape.
- f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor retarder coating or PVDC adhesive tape. The patch shall extend not less than

1-1/2 inches past the break.

- g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor retarder coating or PVDC adhesive tape.

3.2.2.4 Insulation for Fittings and Accessories

- a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating or PVDC adhesive tape.
- b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".
- c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with PVDC adhesive tape or two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches. Fabricated insulation with a factory vapor retarder jacket shall be protected with PVDC adhesive tape or two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, the joints shall be sealed with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.
- d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.
- e. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory precut or premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. The covers shall be secured by PVC vapor retarder tape, adhesive, seal welding or with tacks made for securing PVC covers.

Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

-- End of Section --

SECTION 15182

REFRIGERANT PIPING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 710	(1986) Liquid-Line Driers
ARI 720	(1997) Refrigerant Access Valves and Hose Connectors
ARI 750	(2001) Thermostatic Refrigerant Expansion Valves
ARI 760	(2001) Solenoid Valves for Use With Volatile Refrigerants

ASTM INTERNATIONAL (ASTM)

ASTM A 53/A 53M	(2002) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 653/A 653M	(2002a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 280	(2002) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B 62	(2002) Composition Bronze or Ounce Metal Castings
ASTM B 75	(2002) Seamless Copper Tube
ASTM D 520	(2000) Zinc Dust Pigment
ASTM E 84	(2001) Surface Burning Characteristics of Building Materials

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15	(2001; Errata 2002) Safety Standard for Refrigeration Systems
ASHRAE 17	(1998) Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS BRH	(2002) Brazing Handbook
AWS Z49.1	(1999) Safety in Welding, Cutting and Allied Processes

ASME INTERNATIONAL (ASME)

ASME B16.22	(2002) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	(2001) Power Piping
ASME B31.5	(2001) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2000) Pressure Gauges and Gauge Attachments

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(2002) Pipe Hangers and Supports - Selection and Application

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Refrigerant Piping System

Manufacturer's standard catalog data, at least 4 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. Data shall be provided for the following components as a minimum:

a. Piping and Fittings

- b. Valves
- c. Piping Accessories
- d. Pipe Hangers, Inserts, and Supports

1.3 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Cutting safety requirements shall be in accordance with AWS Z49.1.

1.4 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.5.2 Contract Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

2.2 ELECTRICAL WORK

Electrical equipment and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Field wiring shall be in accordance with manufacturer's instructions. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.3 REFRIGERANT PIPING SYSTEM

Refrigerant piping, valves, fittings, and accessories shall be in accordance with ASHRAE 15 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories shall be compatible with the fluids used and capable of withstanding the pressures and temperatures of the service. Refrigerant piping, valves, and accessories used for refrigerant service shall be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant.

2.4 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

2.4.1 Copper Tubing

Copper tubing shall conform to ASTM B 280 annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 1-3/8 inches. Joints shall be brazed except that joints on lines 7/8 inch and smaller may be flared. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings shall not be allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

2.4.2 Brazing Filler Metal

Filler metal shall conform to AWS A5.8, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.5 VALVES

Valves shall be designed, manufactured, and tested specifically for refrigerant service. Valve bodies shall be of brass, bronze, steel, or ductile iron construction. Valves 1 inch and smaller shall have brazed or connections. Threaded end connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections. Valve stems exposed to the atmosphere shall be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow shall be legibly and permanently indicated on the valve body. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Purge, charge and receiver valves shall be of manufacturer's standard configuration.

2.5.1 Refrigerant Stop Valves

Valve shall be the globe or full-port ball type with a back-seating stem especially packed for refrigerant service. Valve packing shall be replaceable under line pressure. Valve shall be provided with a [handwheel] [or] [wrench] operator and a seal cap. Valve shall be the straight or angle pattern design as indicated.

2.5.2 Check Valves

Valve shall be the swing or lift type as required to provide positive shutoff at the differential pressure indicated. Valve shall be provide with resilient seat.

2.5.3 Liquid Solenoid Valves

Valves shall comply with ARI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have safe working pressure of 400 psi and a maximum operating pressure differential of at least 200 psi at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the refrigerant used.

2.5.4 Expansion Valves

Valve shall conform to ARI 750 and ASHRAE 17. Valve shall be the diaphragm and spring-loaded type with internal or external equalizers, and bulb and capillary tubing. Valve shall be provided with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 2 degrees F of saturated suction temperature at evaporator conditions. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. An isolatable pressure gauge shall be provided in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicted or for constant evaporator loads.

2.5.5 Safety Relief Valves

Valve shall be the two-way type, unless indicated otherwise. Valve shall bear the ASME code symbol. Valve capacity shall be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve shall be of an automatically reseating design after activation.

2.5.6 Evaporator Pressure Regulators, Direct-Acting

Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 2 degrees F change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.

2.5.7 Refrigerant Access Valves

Refrigerant access valves and hose connections shall be in accordance with ARI 720.

2.6 PIPING ACCESSORIES

2.6.1 Filter Driers

Driers shall conform to ARI 710. Sizes 5/8 inch and larger shall be the full flow, replaceable core type. Sizes 1/2 inch and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 1,500 psi.

2.6.2 Sight Glass and Liquid Level Indicator

2.6.2.1 Assembly and Components

Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type. Ferrous components subject to condensation shall be electro-galvanized.

2.6.2.2 Gauge Glass

Gauge glass shall include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

2.6.2.3 Bull's-Eye and Inline Sight Glass Reflex Lens

Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighting viewing shall be provided.

2.6.2.4 Moisture Indicator

Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

2.6.3 Vibration Dampeners

Dampeners shall be of the all-metallic bellows and woven-wire type.

2.6.4 Flexible Pipe Connectors

Connector shall be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly shall be constructed with a safety factor of not less than 4 at 300 degrees F. Unless otherwise indicated, the length of a flexible connector shall be as recommended by the manufacturer for the service intended.

2.6.5 Strainers

Strainers used in refrigerant service shall have brass or cast iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens shall be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.6.6 Pressure and Vacuum Gauges

Gauges shall conform to ASME B40.100 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 3-1/2 inches in diameter with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.6.7 Temperature Gauges

Temperature gauges shall be the industrial duty type and be provided for the required temperature range. Gauges shall have Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 5 to 7 feet above the finished floor. Remote element type temperature gauges shall be provided in thermal wells located 7 feet above the finished floor.

2.6.7.1 Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 9 inches long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2.6.7.2 Bimetallic Dial

Bimetallic dial type case shall be not less than 3-1/2 inches, stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment. Accuracy shall be one percent of dial range.

2.6.7.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases shall be not less than 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

2.6.7.4 Thermal Well

Thermal well shall be identical size, 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1 inch.

2.6.8 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports shall conform to MSS SP-58 and MSS SP-69.

2.6.9 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.7 FABRICATION

2.7.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

2.7.2 Factory Applied Insulation

Refrigerant suction lines between the cooler and each compressor shall be insulated with not less than 3/4 inch thick unicellular plastic foam. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

2.8 FIELD APPLIED INSULATION

Field applied insulation shall be provided and installed in accordance with Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

PART 3 EXECUTION

3.1 INSTALLATION

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

3.1.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

3.1.2 Functional Requirements

Piping shall be installed 1/2 inch per 10 feet of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

3.1.3 Fittings and End Connections

3.1.3.1 Brazed Connections

Brazing shall be performed in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations.

Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Piping shall be supported prior to brazing and not be sprung or forced.

3.1.4 Valves

3.1.4.1 General

Refrigerant stop valves shall be installed on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Stop valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches shall be external to thermal insulation. Safety switches shall not be fitted with isolation valves. Filter dryers having access ports may be considered a point of isolation. Purge valves shall be provided at all points of systems where accumulated noncondensable gases would prevent proper system operation. Valves shall be furnished to match line size, unless otherwise indicated or approved.

3.1.4.2 Expansion Valves

Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 2-1/8 inches in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 2-1/8 inches. The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall be installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

3.1.4.3 Valve Identification

Each system valve, including those which are part of a factory assembly, shall be tagged. Tags shall be in alphanumeric sequence, progressing in direction of fluid flow. Tags shall be embossed, engraved, or stamped plastic or nonferrous metal of various shapes, sized approximately 1-3/8 inch diameter, or equivalent dimension, substantially attached to a component or immediately adjacent thereto. Tags shall be attached with nonferrous, heavy duty, bead or link chain, 14 gauge annealed wire, nylon cable bands or as approved. Tag numbers shall be referenced in Operation and Maintenance Manuals and system diagrams.

3.1.5 Vibration Dampers

Vibration damper shall be provided in the suction and discharge lines on spring mounted compressors. Vibration dampers shall be installed parallel with the shaft of the compressor and shall be anchored firmly at the upstream end on the suction line and the downstream end in the discharge line.

3.1.6 Strainers

Strainers shall be provided immediately ahead of solenoid valves and expansion devices. Strainers may be an integral part of an expansion valve.

3.1.7 Filter Dryer

A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturer's recommendations

for the system in which it is installed. Dryers shall be installed such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.1.8 Sight Glass

A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers and where indicated. Site glasses shall be full line size.

3.1.9 Discharge Line Oil Separator

Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.

3.1.10 Accumulator

Accumulators shall be provided in the suction line to each compressor.

3.1.11 Flexible Pipe Connectors

Connectors shall be installed perpendicular to line of motion being isolated. Piping for equipment with bidirectional motion shall be fitted with two flexible connectors, in perpendicular planes. Reinforced elastomer flexible connectors shall be installed in accordance with manufacturer's instructions. Piping guides and restraints related to flexible connectors shall be provided as required.

3.1.12 Temperature Gauges

Temperature gauges shall be located specifically on, but not limited to the following: the sensing element of each automatic temperature control device where a thermometer is not an integral part thereof. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1 inch.

3.1.13 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.13.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.13.2 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.1.13.3 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.13.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.13.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

3.1.13.6 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves.

3.1.13.7 Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.13.8 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.13.9 High Temperature Guides with Cradles

Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

3.1.13.10 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.13.11 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for support shall be as specified under Section 05120 STRUCTURAL STEEL.

3.1.14 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.15 Pipe Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Detailed drawings of pipe anchors shall be submitted for approval before installation.

3.1.16 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A 653/A 653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A 53/A 53M, Standard weight. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

3.1.16.1 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves.

3.1.17 Field Applied Insulation

Field installed insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.1.18 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTS AND COATINGS.

3.2 CLEANING AND ADJUSTING

Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture, contaminated refrigerant, or any foreign matter shall be considered contaminated systems. Restoring contaminated systems to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging, shall be performed using currently approved refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost to the Government as determined by the Contracting Officer. Water shall not be used in any procedure or test.

3.3 REFRIGERANT PIPING TESTS

After all components of the refrigerant system have been installed and connected, the entire refrigeration system shall be subjected to pneumatic, evacuation, and startup tests as described herein. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein.

3.3.1 Preliminary Procedures

Prior to pneumatic testing, equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, shall be isolated from the test pressure or removed from the system. Safety relief valves and rupture discs, where not part of factory sealed systems, shall be removed and openings capped or plugged.

3.3.2 Pneumatic Test

Pressure control and excess pressure protection shall be provided at the source of test pressure. Valves shall be wide open, except those leading to the atmosphere. Test gas shall be dry nitrogen, with minus 70 degree F dewpoint and less than 5 ppm oil. Test pressure shall be applied in two stages before any refrigerant pipe is insulated or covered. First stage test shall be at 10 psi with every joint being tested with a thick soap or color indicating solution. Second stage tests shall raise the system to the minimum refrigerant leakage test pressure specified in ASHRAE 15 with a maximum test pressure 25 percent greater. Pressure above 100 psig shall be raised in 10 percent increments with a pressure acclimatizing period between increments. The initial test pressure shall be recorded along with the ambient temperature to which the system is exposed. Final test pressures of the second stage shall be maintained on the system for a minimum of 24 hours. At the end of the 24 hour period, the system pressure will be recorded along with the ambient temperature to which the system is

exposed. A correction factor of 0.3 psi will be allowed for each degree F change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, then the system shall be investigated for leaking joints. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing shall not be acceptable. Following repair, the entire system shall be retested using the pneumatic tests described above. The entire system shall be reassembled once the pneumatic tests are satisfactorily completed.

3.3.3 Evacuation Test

Following satisfactory completion of the pneumatic tests, the pressure shall be relieved and the entire system shall be evacuated to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature shall be higher than 35 degrees F. No more than one system shall be evacuated at one time by one vacuum pump. Once the desired vacuum has been reached, the vacuum line shall be closed and the system shall stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, then the system shall be evacuated again down to 300 micrometers and let set for another 1 hour period. The system shall not be charged until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure. During evacuation, pressures shall be recorded by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

3.3.4 System Charging and Startup Test

Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures.

Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The entire system shall be tested for leaks. Fluorocarbon systems shall be tested with halide torch or electronic leak detectors.

3.3.5 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

3.3.6 Contractor's Responsibility

The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim.

At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is

the result of defective equipment, material, or installation.

-- End of Section --

SECTION 15700

UNITARY HEATING AND COOLING EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

- | | |
|---------|--|
| ARI 460 | (2000) Remote Mechanical-Draft Air-Cooled Refrigerant Condensers |
| ARI 700 | (1999) Specifications for Fluorocarbon and Other Refrigerants |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|-------------|--|
| ASTM A 307 | (2000) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength |
| ASTM C 1071 | (1998) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material) |
| ASTM E 437 | (1992; R 1997) Industrial Wire Cloth and Screens (Square Opening Series) |
| ASTM E 84 | (2000a) Surface Burning Characteristics of Building Materials |
| ASTM F 104 | (1995) Nonmetallic Gasket Materials |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

- | | |
|-------------|--|
| ASHRAE 15 | (1994) Safety Code for Mechanical Refrigeration |
| ASHRAE 34 | (1997) Number Designation and Safety Classification of Refrigerants |
| ASHRAE 52.1 | (1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter |

AMERICAN WELDING SOCIETY (AWS)

- | | |
|-----------|--------------------------------------|
| AWS Z49.1 | (1999) Safety in Welding and Cutting |
|-----------|--------------------------------------|

ASME INTERNATIONAL (ASME)

ASME BPVC SEC IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA MG 1	(1998) Motors and Generators
NEMA MG 2	(1989) Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
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UNDERWRITERS LABORATORIES (UL)

UL 1995	(1995; Rev thru Aug 1999) Heating and Cooling Equipment
UL 207	(1993; Rev thru Oct 1997) Refrigerant-Containing Components and Accessories, Nonelectrical
UL 586	(1996; Rev thru Aug 1999) High-Efficiency, Particulate, Air Filter Units
UL 900	(1994; Rev thru Nov 1999) Test Performance of Air Filter Units

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G

Drawings provided in adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

- a. Equipment layouts which identify assembly and installation details.
- b. Plans and elevations which identify clearances required for

maintenance and operation.

c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

SD-03 Product Data

Unitary Equipment; G

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Data shall be submitted for each specified component.

Posted Instructions; G

Posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

Verification of Dimensions; G

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

System Performance Tests

A schedule for the system performance tests. The schedules shall identify the proposed date, time, and location for each test.

Demonstrations; G

A schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

SD-06 Test Reports

Refrigerant Tests, Charging, and Start-Up; G

Six copies of each test containing the information described below in bound 8-1/2 x 11 inch booklets. Individual reports shall be submitted for the refrigerant system tests.

- a. The date the tests were performed.
- b. A list of equipment used, with calibration certifications.
- c. Initial test summaries.
- d. Repairs/adjustments performed.
- e. Final test results.

System Performance Tests; G

Six copies of the report provided in bound 8-1/2 x 11 inch booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report shall also include the following information and shall be taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart:

- a. Date and outside weather conditions.
- b. The load on the system based on the following:
 - (1) The refrigerant used in the system.
 - (2) Condensing temperature and pressure.
 - (3) Suction temperature and pressure.
 - (4) Ambient, condensing and coolant temperatures.
 - (5) Running current, voltage and proper phase sequence for each phase of all motors.
- c. The actual on-site setting of operating and safety controls.
- d. Thermostatic expansion valve superheat - value as determined by field test.
- e. Subcooling.
- f. High and low refrigerant temperature switch set-points
- g. Low oil pressure switch set-point.
- h. Moisture content.
- i. Capacity control set-points.

j. Field data and adjustments which affect unit performance and energy consumption.

k. Field adjustments and settings which were not permanently marked as an integral part of a device.

SD-10 Operation and Maintenance Data

Operation Manuals; G

Six complete copies of an operation manual in bound 8 1/2 x 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 2 weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manuals

Six complete copies of maintenance manual in bound 8-1/2 x 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

1.3 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

1.4 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.5.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to

be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

2.2 NAMEPLATES

Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of anodized aluminum. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.3 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.4 UNITARY EQUIPMENT, SPLIT SYSTEM, DEHUMIDIFIER

Unit shall be an air-cooled, split system dehumidifier which employs a remote condenser, a separate indoor unit with heat reclaim circuiting, and interconnecting refrigerant piping. Unit shall be the air-conditioning type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be provided with necessary fans, air filters, coils, liquid receiver, internal dampers, and cabinet construction as specified in paragraph "Unitary Equipment Components". The remote unit shall be as specified in paragraph REMOTE CONDENSER. Evaporator or supply fan and condenser fan shall be forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Fan and condenser motors shall have dripproof enclosures.

2.4.1 Air-to-Refrigerant Coil

Coils shall have nonferrous tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.4.2 Compressor

Compressor shall be direct drive, semi-hermetic or hermetic reciprocating, or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. The compressor shall be provided with vibration isolators, crankcase heater, thermal overloads, high and low pressure safety cutoffs and protection against short cycling.

2.4.3 Refrigeration Circuit

Refrigerant-containing components shall comply with ASHRAE 15 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control.

2.4.4 Unit Controls

Unit shall be internally prewired with a 24 volt control circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall have cutoffs for high and low pressure, and safety interlocks on all service panels. Adjustable-cycle timers shall prevent short-cycling. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995.

2.5 REMOTE CONDENSER

Each remote condenser coil shall be fitted with a manual isolation valve

and an access valve on the coil side. Saturated refrigerant condensing temperature shall not exceed 120 degrees F at 95 degrees F ambient. Fan and cabinet construction shall be provided as specified in paragraph "Unitary Equipment Components". Fan and condenser motors shall have dripproof enclosures.

2.5.1 Air-Cooled Condenser

Unit shall be rated in accordance with ARI 460 and conform to the requirements of UL 1995. Unit shall be factory fabricated, tested, packaged, and self-contained. Unit shall be complete with casing, centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.

2.5.1.1 Connections

Interconnecting refrigeration piping, electrical power, and control wiring between the condenser and the indoor unit shall be provided as required and as indicated. Electrical and refrigeration piping terminal connections between condenser and evaporator units shall be provided.

2.5.1.2 Condensing Coil

Coils shall have nonferrous tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.5.1.3 Unit Controls

The control system shall be complete with required accessories for regulating condenser pressure by fan cycling, modulating condenser coil, flooding the condenser, or a combination of the above. Unit mounted control panels or enclosures shall be constructed in accordance with applicable requirements of NFPA 70 and housed in NEMA ICS 6, Class 1 or 3A enclosures. Controls shall include control transformer, fan motor starter, time delay start-up, overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.6 UNITARY EQUIPMENT COMPONENTS

2.6.1 Refrigerant and Oil

Refrigerant shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ASHRAE 34. Refrigerants shall meet the requirements of ARI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05. Contractor shall provide and install a complete charge of refrigerant for the installed system as recommended by the manufacturer. Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase shall be furnished. One charge shall be used during the system performance testing period. Following the satisfactory completion of the performance testing, the oil

shall be drained and replaced with a second charge. Lubricating oil shall be of a type and grade recommended by the manufacturer for each compressor.

Where color leak indicator dye is incorporated, charge shall be in accordance with manufacturer's recommendation.

2.6.2 Fans

Fan wheel shafts shall be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans shall be selected to produce the cfm required at the fan total pressure. Motor starters, if applicable, shall be magnetic across-the-line type with a drip-proof enclosure. Thermal overload protection shall be of the manual or automatic-reset type. Fan wheels or propellers shall be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings shall be of galvanized steel, and centrifugal fan casings shall be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, shall be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting shall be recoated with an approved zinc-rich compound. Fan wheels shall be statically and dynamically balanced. The sheave size shall be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans shall be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. V-belt driven fans shall be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings shall be protected with water slingers or shields. V-belt drives shall be fitted with guards where exposed to contact by personnel and fixed pitch sheaves.

2.6.3 Air Filters

Air filters shall be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test Method shall be as listed under the label service and shall meet the requirements of UL 586.

2.6.3.1 Extended Surface Pleated Panel Filters

Filters shall be 2 inch depth sectional type of the size indicated and shall have an average efficiency of 25 to 30 percent when tested in accordance with ASHRAE 52.1. Initial resistance at 500 feet per minute will not exceed 0.36 inches water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. Four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.6.4 Pressure Vessels

Pressure vessels shall conform to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, pressure components shall be tested at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces shall be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed.

2.6.5 Cabinet Construction

Casings for the specified unitary equipment shall be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces shall be 18 gauge galvanized steel or 0.071 inch thick aluminum on units with a capacity above 20 tons and 20 gauge galvanized steel or 0.064 inch thick aluminum on units with a capacity less than 20 tons. Casing shall be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Provisions to permit replacement of major unit components shall be incorporated. Penetrations of cabinet surfaces, including the floor, shall be sealed. Unit shall be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan shall be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation shall be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces shall prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation shall conform to ASTM C 1071. Paint and finishes shall comply with the requirements specified in paragraph FACTORY COATING.

2.6.5.1 Indoor Cabinet

Indoor cabinets shall be suitable for the specified indoor service and enclose all unit components.

2.7 ACCESSORIES

2.7.1 Gaskets

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.7.2 Bolts and Nuts

Bolts and nuts shall be in accordance with ASTM A 307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A 307.

2.7.3 Bird Screen

Screen shall be in accordance with ASTM E 437, Type 1, Class 1, 2 by 2 mesh, 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire.

2.8 FABRICATION

2.8.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish.

2.8.2 Factory Applied Insulation

Refrigeration equipment shall be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation shall be provided on the cold-gas inlet connection to the motor per manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

2.9 SUPPLEMENTAL COMPONENTS/SERVICES

2.9.1 Refrigerant Piping

Refrigerant piping for split-system unitary equipment shall be provided and installed in accordance with Section 15182 REFRIGERANT PIPING.

2.9.2 Ductwork

Ductwork shall be provided and installed in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

2.9.3 Temperature Controls

Temperature controls shall be fully coordinated with and integrated into the UMCS (DDC) control system to meet the sequences of operation indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D and ASME BPVC SEC IX, the design, fabrication, and installation of the system shall conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.1.1 Equipment

Refrigeration equipment and the installation thereof shall conform to ASHRAE 15. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for air handling units, condensers, and similar items. Compressors shall be isolated from the building structure. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.1.2 Field Applied Insulation

Field applied insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.2 CLEANING AND ADJUSTING

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.3 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems shall be tested and charged as specified in Section 15182 REFRIGERANT PIPING. Packaged refrigerant systems which are factory charged shall be checked for refrigerant and oil capacity to verify proper refrigerant levels per manufacturer's recommendations. Following charging, packaged systems shall be tested for leaks with a halide torch or an electronic leak detector.

3.3.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

3.3.2 Contractor's Responsibility

The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim.

At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.4 SYSTEM PERFORMANCE TESTS

Before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than 48 hours for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to

demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be installed and tightened. Any refrigerant lost during the system startup shall be replaced. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. Field tests shall be coordinated with Section 13801 UTILITY MONITORING AND CONTROL SYSTEM (UMCS).

3.5 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 2 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

-- End of Section --

SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI Guideline D (1996) Application and Installation of
Central Station Air-Handling Units

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 210 (1999) Laboratory Methods of Testing Fans
for Aerodynamic Performance Rating

AMCA 300 (1996) Reverberant Room Method for Sound
Testing of Fans

ASTM INTERNATIONAL (ASTM)

ASTM A 53/A 53M (2001) Pipe, Steel, Black and Hot-Dipped,
Zinc-Coated, Welded and Seamless

ASTM E 437 (1992; R 1997) Industrial Wire Cloth and
Screens (Square Opening Series)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 70 (1991) Method of Testing for Rating the
Performance of Air Outlets and Inlets

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (1998) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (1999) Installation of Air Conditioning
and Ventilating Systems

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

SMACNA HVAC Duct Const Stds (1995; Addenda Nov 1997; 6th Printing
2001) HVAC Duct Construction Standards -

Metal and Flexible

UNDERWRITERS LABORATORIES (UL)

UL 214 (1997; Rev thru Aug 2001) Tests for
Flame-Propagation of Fabrics and Films

UL Bld Mat Dir (1999) Building Materials Directory

1.2 COORDINATION OF TRADES

Ductwork, piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other new or existing construction.

1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

1.4 FIELD MEASUREMENTS

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year manufacturer's experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

2.3 NAMEPLATES

Equipment shall have a nameplate installed by the manufacturer that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements.

2.5 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 10 hp or less. Adjustable frequency drives shall be used for larger motors.

2.6 CONTROLS

Controls shall be provided as specified in Section 13801 UTILITY MONITORING AND CONTROL SYSTEM (UMCS).

2.7 DUCTWORK COMPONENTS

2.7.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA HVAC Duct Const Stds unless otherwise specified. Elbows shall be radius type with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure 1/2 shall meet the requirements of Seal Class C. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA HVAC Duct Const Stds. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

2.7.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum

of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

2.7.1.2 General Service Duct Connectors

A flexible duct connector approximately 6 inches in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Bld Mat Dir.

2.7.2 Ductwork Accessories

2.7.2.1 Duct Access Doors

Access doors shall be provided in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA HVAC Duct Const Stds. Access doors shall be provided upstream and downstream of air flow measuring primaries and heating and cooling coils. Doors shall be minimum 15 x 18 inches, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 24 x 24 inches or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type.

2.7.3 Duct Sleeves, Framed Prepared Openings, Closure Collars

2.7.3.1 Duct Sleeves

Sleeves and framed openings are also required where grilles are installed at the openings. Framed prepared openings shall be fabricated from 20 gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53/A 53M, Schedule 20 shall be used. Sleeve shall provide 1 inch clearance between the duct and the sleeve or 1 inch clearance between the insulation and the sleeve for insulated ducts.

2.7.3.2 Framed Prepared Openings

Openings shall have 1 inch clearance between the duct and the opening.

2.7.4 Grilles

Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ASHRAE 70. Inlets and outlets shall be sound rated and certified according to ASHRAE 70. Sound power level shall be as indicated. Diffusers and registers shall be provided with volume damper with accessible operator,

unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, they shall be protected by a grille or screen according to NFPA 90A.

2.7.4.1 Grilles

Units shall be fixed horizontal or vertical louver type.

2.7.5 Louvers

Louvers for installation in exterior walls which are associated with the air supply and distribution system shall be as specified in Section 07600 FLASHING AND SHEET METAL.

2.7.6 Bird Screens and Frames

Bird screens shall conform to ASTM E 437, No. 2 mesh, aluminum or stainless steel. Aluminum screens shall be rated "medium-light". Stainless steel screens shall be rated "light". Frames shall be removable type, or stainless steel or extruded aluminum.

2.8 AIR SYSTEMS EQUIPMENT

2.8.1 Fans

Fans shall be tested and rated according to AMCA 210. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than 150 percent of the connected driving capacity. Motor sheaves shall be variable pitch for 15 hp and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts.

Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

2.8.1.1 Centrifugal Type Power Roof Ventilators

Fans shall be direct or V-belt driven with backward inclined, non-overloading wheel. Motor compartment housing shall be hinged or removable and weatherproof, constructed of heavy gauge aluminum. Fans shall be provided with birdscreen, disconnect switch, gravity dampers, and roof curb. Motors enclosure shall be dripproof type. Lubricated bearings

shall be provided.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

3.1.1 Access Panels

Access panels shall be provided for concealed controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced.

3.1.2 Flexible Connectors

Pre-insulated flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

3.1.3 Metal Ductwork

Installation shall be according to SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be used. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

3.1.4 Duct Test Holes

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

3.1.5 Power Roof Ventilator Mounting

Foamed 1/2 inch thick, closed-cell, flexible elastomer insulation shall cover width of roof curb mounting flange. Where wood nailers are used, holes shall be pre-drilled for fasteners.

3.1.6 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.2 FIELD PAINTING AND IDENTIFICATION SYSTEMS

3.2.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number shall be installed on all valves and dampers. Tags shall be 1-3/8 inch minimum diameter and marking shall be stamped or engraved. Indentations shall be black for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.3 CLEANING AND ADJUSTING

Inside of air handling units, ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

-- End of Section --

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 709 (2001) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 100 (2000) Dictionary of Electrical and Electronics Terms (IEEE)

IEEE C2 (2002) National Electrical Safety Code (IEEE)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6 (1993; R 2001) Industrial Control and Systems Enclosures

NEMA MG 1 (1998; R 2002) Motors and Generators

NEMA MG 10 (2001) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors

NEMA MG 11 (1977; R 2001) Energy Management Guide for Selection and Use of Single-Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

1.2 RELATED REQUIREMENTS

This section applies to all sections of Division 16, "Electrical," of this project specification unless specified otherwise in the individual sections.

1.3 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.
- b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed

description of submittal types.

- c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 277/480 volt primary, three phase, four wire, 60 Hz, and 120/208 volts secondary, three phase, four wire. Final connections to the power distribution system at the service trough near the Power Company Transformer shall be made by the Contractor as directed by the Contracting Officer. The final connections inside the Power Company Transformer shall be made by the Power Company.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

Submittals required in the sections which refer to this section must also conform to the following additional requirements. Submittals shall include the manufacturer's name, trade name, place of manufacture, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and technical paragraph reference. Submittals shall also include applicable federal, military, industry, and technical society publication references, and years of satisfactory service, and other information necessary to establish contract compliance of each item to be provided. Photographs of existing installations are unacceptable and will be returned without approval.

1.5.1 Manufacturer's Catalog Data

Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts. Handwritten and typed modifications and other notations not part of the manufacturer's preprinted data will result in the rejection of the submittal. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified for certificates of compliance.

1.5.2 Drawings

Submit drawings a minimum of 14 by 20 inches in size using a minimum scale of 1/8 inch per foot, except as specified otherwise. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.5.3 Instructions

Where installation procedures or part of the installation procedures are required to be in accordance with manufacturer's instructions, submit printed copies of those instructions prior to installation. Installation of the item shall not proceed until manufacturer's instructions are received. Failure to submit manufacturer's instructions shall be cause for rejection of the equipment or material.

1.5.4 Certificates

Submit manufacturer's certifications as required for products, materials, finishes, and equipment as specified in the technical sections. Certificates from material suppliers are not acceptable. Preprinted certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance.

1.5.4.1 Reference Standard Compliance

Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), Underwriters Laboratories (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.

1.5.4.2 Independent Testing Organization Certificate

In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.5.5 Operation and Maintenance Manuals

Comply with the requirements of Section 01010, "Operation and Maintenance Data" and the related technical requirements.

1.5.5.1 Operating Instructions

Submit text of posted operating instructions for each system and principal item of equipment as specified in the technical sections.

1.6 QUALITY ASSURANCE

1.6.1 Material and Equipment Qualifications

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

1.6.2 Regulatory Requirements

Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70.

1.6.3 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.4 Service Support

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.5 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.6.6 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer.

1.6.7 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The

operating instructions shall include the following:

- a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
- b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
- c. Safety precautions.
- d. The procedure in the event of equipment failure.
- e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.8 NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each panelboard, equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Provide red laminated plastic label with white center core where indicated. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

1.9 CABLE TAGS IN MANHOLES, HANDHOLES, AND VAULTS

Provide tags for each power and telecommunications cable or wire located in handholes and pullboxes.

1.10 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.10.1 Motors and Equipment

Provide electrical components of mechanical equipment, such as motors, motor starters, control or push-button stations, float or pressure switches, solenoid valves, and other devices functioning to control mechanical equipment, including control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors shall not be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, the motor control equipment forming a part of motor control centers, and the electrical power circuits shall be provided under Division 16.

1.10.2 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment, and motor control equipment forming part of motor control centers, the conduit and wiring connecting such centers, assemblies, or other power sources to equipment under Section 16415N, "Electrical Work, Interior."

1.10.3 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 16.

1.10.4 High Efficiency Motors

1.10.4.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors shall be high efficiency types corresponding to the applications listed in NEMA MG 11.

1.10.4.2 High Efficiency Polyphase Motors

Unless otherwise specified, polyphase motors shall be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with continuous ratings shall meet or exceed energy efficient ratings in accordance with Table 12-10 of NEMA MG 1.

1.10.5 Three-Phase Motor Protection

Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PAINTING OF EQUIPMENT

3.1.1 Factory Applied

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test and the additional requirements specified in the technical sections.

3.1.2 Field Applied

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

3.2 NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

-- End of Section --

SECTION 16410

AUTOMATIC TRANSFER SWITCH AND BY-PASS/ISOLATION SWITCH

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.13 (1990; R 1995) Low-Voltage AC Power Circuit Breakers Used in Enclosures

IEEE C37.90.1 (1989; R 1994) IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems

IEEE C62.41 (1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

IEEE Std 602 (1996) Electric Systems in Health Care Facilities

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1 (1993) Industrial Controls and Systems

NEMA ICS 2 (1993) Industrial Controls and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC

NEMA ICS 4 (1997) Industrial Control and Systems Terminal Blocks

NEMA ICS 6 (1993) Industrial Control and Systems, Enclosures

NEMA ICS 10 (1999) Industrial Control and Systems: AC Transfer Switch Equipment - Part 2: Static AC Transfer Equipment

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

NFPA 110 (1999) Emergency and Standby Power Systems

UNDERWRITERS LABORATORIES (UL)

UL 1008	(1996; Rev thru Feb 1999) Transfer Switch Equipment
UL 1066	(1997) Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Automatic Transfer Switches; G

Schematic, external connection, one-line schematic and wiring diagram of each ATS assembly. Interface equipment connection diagram showing conduit and wiring between ATS and related equipment. Device, nameplate, and item numbers shown in list of equipment and material shall appear on drawings wherever that item appears. Diagrams shall show interlocking provisions and cautionary notes, if any. Operating instructions shall be shown either on one-line diagram or separately. Unless otherwise approved, one-line and elementary or schematic diagrams shall appear on same drawing.

Equipment; G
Installation; G

Dimensioned plans, sections and elevations showing minimum clearances, weights, and conduit entry provisions for each ATS.

SD-03 Product Data

Material; G
Equipment; G

List of proposed equipment and material, containing a description of each separate item.

SD-06 Test Reports

Testing; G

A description of proposed field test procedures, including proposed date and steps describing each test, its duration and expected results, not less than 2 weeks prior to test date.

Certified factory and field test reports, within 14 days following completion of tests. Reports shall be certified and dated and shall demonstrate that tests were successfully completed prior to shipment of equipment.

SD-07 Certificates

Equipment; G
Material; G

Certificates of compliance showing evidence of UL listing and conformance with applicable NEMA standards. Such certificates are not required if manufacturer's published data, submitted and approved, reflect UL listing or conformance with applicable NEMA standards.

Switching Equipment; G

Evidence that ATS withstand current rating (WCR) has been coordinated with upstream protective devices as required by UL 1008. Upon request, manufacturer shall also provide notarized letter certifying compliance with requirements of this specification, including withstand current rating.

SD-10 Operation and Maintenance Data

Switching Equipment; G
Instructions; G

Six copies of operating manual outlining step-by-step procedures for system startup, operation, and shutdown. Manual shall include manufacturer's name, model number, service manual, parts list, and brief description of equipment and basic operating features. Manufacturer's spare parts data shall be included with supply source and current cost of recommended spare parts. Six copies of maintenance manual listing routine maintenance, possible breakdowns, repairs, and troubleshooting guide. Manual shall include simplified wiring and control diagrams for system as installed.

1.3 GENERAL REQUIREMENTS

1.3.1 Standard Product

Material and equipment shall be standard products of a manufacturer regularly engaged in manufacturing the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. The experience use shall include applications in similar circumstances and of same design and rating as specified ATS. Equipment shall be capable of being serviced by a manufacturer-authorized and trained organization that is, in the Contracting Officer's opinion, reasonably convenient to the site.

1.3.2 Nameplate

Nameplate showing manufacturer's name and equipment ratings shall be made of corrosion-resistant material with not less than 1/8 inch tall characters. Nameplate shall be mounted to front of enclosure and shall comply with nameplate requirements of NEMA ICS 2.

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH (ATS)

ATS shall be electrically operated and mechanically held in both operating

positions. ATS shall be suitable for use in emergency systems described in NFPA 70. ATS shall be UL listed. ATS shall be manufactured and tested in accordance with applicable requirements of IEEE C37.90.1, IEEE C37.13, IEEE C62.41, IEEE Std 602, NEMA ICS 1, NEMA ICS 2, NEMA ICS 10, UL 1008 and UL 1066. ATS shall conform to NFPA 110. To facilitate maintenance, manufacturer's instruction manual shall provide typical maximum contact voltage drop readings under specified conditions for use during periodic maintenance. Manufacturer shall provide instructions for determination of contact integrity. ATS shall be rated for continuous duty at specified continuous current rating. ATS shall be fully compatible and approved for use with BP/IS specified. BP/IS shall be considered part of ATS system. ATS shall have following characteristics:

- a. Voltage: 480 volts ac.
- b. Number of Phases: Three.
- c. Number of Wires: Four.
- d. Frequency: 60 Hz.
- e. Poles: Three switched and solid neutral.
- f. ATS WCR: Rated to withstand short-circuit current of 25,000 amperes, RMS symmetrical.
- g. Nonwelding Contacts: Rated for nonwelding of contacts when used with upstream feeder overcurrent devices shown and with available fault current specified.
- h. Main and Neutral Contacts: Contacts shall have silver alloy composition. Neutral contacts shall have same continuous current rating as main or phase contacts.

2.1.1.1 Override Time Delay

Time delay to override monitored source deviation shall be adjustable from 0.5 to 6 seconds and factory set at 1 second. ATS shall monitor phase conductors to detect and respond to sustained voltage drop of 10 percent of nominal between any two normal source conductors and initiate transfer action to emergency source and start engine driven generator after set time period. Pickup voltage shall be adjustable from 85 to 100 percent of nominal and factory set at 90 percent. Dropout voltage shall be adjustable from 75 to 98 percent of pickup value and factory set at 85 percent of nominal.

2.1.1.2 Transfer Time Delay

Time delay before transfer to emergency power source shall be adjustable from 0 to 5 minutes and factory set at 0 minutes. ATS shall monitor frequency and voltage of emergency power source and transfer when frequency and voltage are stabilized. Pickup voltage shall be adjustable from 85 to 100 percent of nominal and factory set at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal and factory set at 90 percent.

2.1.1.3 Return Time Delay

Time delay before return transfer to normal power source shall be

adjustable from 0 to 30 minutes and factory set at 15 minutes. Time delay shall be automatically defeated upon loss or sustained undervoltage of emergency power source, provided that normal supply has been restored.

2.1.4 Engine Shutdown Time Delay

Time delay shall be adjustable from 0 to 30 minutes and shall be factory set at 10 minutes.

2.1.5 Exerciser

Provide a generator exerciser timer. Run times shall be user programmable. The generator exerciser shall be selectable between load transfer and engine run only, and shall have a fail-safe feature that will retransfer the ATS to normal during the exercise period.

2.1.6 Auxiliary Contacts

Three normally open and three normally closed auxiliary contacts rated at 15 amperes at 120 volts shall operate when ATS is connected to normal power source, and three normally open and three normally closed contacts shall operate when ATS is connected to emergency source.

2.1.7 Supplemental Features

ATS shall be furnished with the following:

- a. Engine start contact.
- b. Emergency source monitor.
- c. Test switch to simulate normal power outage.
- d. Voltage sensing. Pickup voltage adjustable from 85 to 100 percent of nominal; dropout adjustable from 75 to 98 percent of pickup.
- e. Time delay bypass switch to override return time delay to normal.
- f. Manual return-to-normal switch.
- g. Means shall be provided in the ATS to insure that motor/transformer load inrush currents do not exceed normal starting currents. This shall be accomplished with either in-phase monitoring, time-delay transition, or load voltage decay sensing methods. If manufacturer supplies an in-phase monitoring system, the manufacturer shall indicate under what conditions a transfer cannot be accomplished. If the manufacturer supplies a time-delay transition system, the manufacturer shall supply recommendations for establishing time delay. If load voltage decay sensing is supplied, the load voltage setting shall be user programmable.

2.1.8 Operator

Manual operator conforming to UL 1008 shall be provided, and shall incorporate features to prevent operation by unauthorized personnel. ATS shall be designed for safe manual operation under full load conditions. If manual operation is accomplished by opening the door, then a dead-front shall be supplied for operator safety.

2.1.9 Override Switch

Override switch shall bypass automatic transfer controls so ATS will transfer and remain connected to emergency power source, regardless of condition of normal source. If emergency source fails and normal source is available, ATS shall automatically retransfer to normal source.

2.1.10 Green Indicating Light

A green indicating light shall supervise/provide normal power source switch position indication and shall have a nameplate engraved NORMAL.

2.1.11 Red Indicating Light

A red indicating light shall supervise/provide emergency power source switch position indication and shall have a nameplate engraved EMERGENCY.

2.2 BY-PASS/ISOLATION SWITCH (BP/IS)

2.2.1 Design

Bypass/isolation switch (BP/IS) shall permit load by-pass to either normal or emergency power source and complete isolation of associated ATS, independent of ATS operating position. BP/IS and associated ATS shall be products of same manufacturer and shall be completely interconnected and tested at factory and at project site as specified. BP/IS shall be manufactured, listed, and tested in accordance with paragraph AUTOMATIC TRANSFER SWITCH (ATS) and shall have electrical ratings that exceed or equal comparable ratings specified for ATS. Operating handles shall be externally operated and arranged so that one person can perform the bypass and isolation functions through the operation of a maximum of two handles within 5 seconds. The ATS shall have provisions for locking in the isolation position. Handle for manual operation shall be permanently attached to operating mechanism. BP/IS operation shall be accomplished without disconnecting switch load terminal conductors. Isolation handle positions shall be marked with engraved plates or other approved means to indicate position or operating condition of associated ATS, as follows:

- a. Indication shall be provided to show that ATS section is providing power to the load.
- b. Indication shall be provided of ATS isolation. The ATS controls shall remain functional with the ATS isolated or in bypass mode to permit monitoring of the normal power source and automatic starting of the generator in the event of a loss of the normal power source. In the isolated mode, the bypass section shall be capable of functioning as a manual transfer switch to transfer the load to either power source. The ATS shall be capable of undergoing functional operation testing without service interruption. The ATS may also be completely removed from the enclosure, if required for maintenance or repair, while the bypass section continues to power the load.

2.2.2 Switch Construction

Bypass/isolation switch shall be constructed for convenient removal of parts from front of switch enclosure without removal of other parts or disconnection of external power conductors. Contacts shall be as specified

for associated ATS, including provisions for inspection of contacts without disassembly of BP/IS or removal of entire contact enclosure. To facilitate maintenance, manufacturer shall provide instructions for determination of contact integrity. BP/IS and associated ATS shall be interconnected with suitably sized copper bus bars silver-plated at each connection point, and braced to withstand magnetic and thermal forces created at WCR specified for associated ATS.

2.3 ENCLOSURE

ATS and accessories shall be installed in wall-mounted using perforated uni-strut steel channels or free-standing, floor-mounted, unventilated NEMA ICS 6, Type 3R, smooth sheet metal enclosure constructed in accordance with applicable requirements of UL 1066 and/or UL 1008. Door shall have suitable hinges, locking handle latch, and gasketed jamb. Thermostatically controlled heater shall be provided within enclosure to prevent condensation. Metal gauge shall be not less than No. 14. Enclosure shall be equipped with at least two approved grounding lugs for grounding enclosure to facility ground system using No. 6 AWG copper conductors. Factory wiring within enclosure and field wiring terminating within enclosure shall comply with NFPA 70. If wiring is not color coded, wire shall be permanently tagged or marked near terminal at each end with wire number shown on approved detail drawing. Terminal block shall conform to NEMA ICS 4. Terminals shall be arranged for entrance of external conductors from top of enclosure unless required otherwise. Main switch terminals, including neutral terminal if used, shall be pressure type suitable for termination of external copper conductors shown.

2.3.1 Construction

Enclosure shall be constructed for ease of removal and replacement of ATS components and control devices from front without disconnection of external power conductors or removal or disassembly of major components. Enclosure of ATS with BP/IS shall be constructed to protect personnel from energized BP/IS components during ATS maintenance.

2.3.2 Cleaning and Painting

Both the inside and outside surfaces of an enclosure, including means for fastening, shall be protected against corrosion by enameling, galvanizing, plating, powder coating, or other equivalent means. Protection is not required for metal parts that are inherently resistant to corrosion, bearings, sliding surfaces of hinges, or other parts where such protection is impractical. Finish shall be manufacturer's standard material, process, and color and shall be free from runs, sags, peeling, or other defects. An enclosure marked Type 3R, shall be acceptable if there is no visible rust at the conclusion of a salt spray (fog) test using the test method in ASTM B 117, employing a 5 percent by weight, salt solution for 24 hours. Type 4X enclosures are acceptable following performance of the above test with an exposure time of 200 hours.

2.4 TESTING

2.4.1 Factory Testing

A prototype of specified ATS shall be factory tested in accordance with UL 1008. In addition, factory tests shall be performed on each ATS as follows:

- a. Insulation resistance test to ensure integrity and continuity of

entire system.

- b. Main switch contact resistance test.
- c. Visual inspection to verify that each ATS is as specified.
- d. Mechanical test to verify that ATS sections are free of mechanical hindrances.
- e. Electrical tests to verify complete system electrical operation and to set up time delays and voltage sensing settings.

2.4.2 Factory Test Reports

Manufacturer shall provide three certified copies of factory test reports.

2.5 FACTORY TESTING (MEDICAL FACILITIES)

2.5.1 Viewing Ports

ATS and BP/IS switches shall be of draw-out construction. Viewing ports to inspect the contacts without requiring disassembly shall be provided.

2.5.2 Operating Handles

The operating handles shall be externally operated, and designed and constructed not to stop in an intermediate or neutral position during operation, but shall permit load by-pass and transfer switch isolation in no more than two manual operations which can be performed by one person in 5 seconds or less. The transfer speed will be independent of the operational speed of the switch handle or handles.

PART 3 EXECUTION

3.1 INSTALLATION

ATS shall be installed as shown and in accordance with approved manufacturer's instructions.

3.2 INSTRUCTIONS

Manufacturer's approved operating instructions shall be permanently secured to cabinet where operator can see them. One-line and elementary or schematic diagram shall be permanently secured to inside of front enclosure door.

3.3 SITE TESTING

Following completion of ATS installation and after making proper adjustments and settings, site tests shall be performed in accordance with manufacturer's written instructions to demonstrate that each ATS functions satisfactorily and as specified. Contractor shall advise Contracting Officer not less than 5 working days prior to scheduled date for site testing, and shall provide certified field test reports within 2 calendar weeks following successful completion of site tests. Test reports shall describe adjustments and settings made and site tests performed. Minimum operational tests shall include the following:

- a. Insulation resistance shall be tested, both phase-to-phase and

phase-to-ground.

- b. Power failure of normal source shall be simulated by opening upstream protective device. This test shall be performed a minimum of five times.
- c. Power failure of emergency source with normal source available shall be simulated by opening upstream protective device for emergency source. This test shall be performed a minimum of five times.
- d. Low phase-to-ground voltage shall be simulated for each phase of normal source.
- e. Operation and settings shall be verified for specified ATS features, such as override time delay, transfer time delay, return time delay, engine shutdown time delay, exerciser, auxiliary contacts, and supplemental features.
- f. Manual and automatic ATS and BP/IS functions shall be verified.

-- End of Section --

SECTION 16415

ELECTRICAL WORK, INTERIOR

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C39.1 (1981; R 1992) Requirements for Electrical
Analog Indicating Instruments

ANSI C80.5 (1995) Rigid Aluminum Conduit

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 1 (1995) Hard-Drawn Copper Wire

ASTM B 8 (1999) Concentric-Lay-Stranded Copper
Conductors, Hard, Medium-Hard, or Soft

ASTM D 709 (2000) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.13 (1993) Instrument Transformers

IEEE Std 81 (1983) Guide for Measuring Earth
Resistivity, Ground Impedance, and Earth
Surface Potentials of a Ground System
(Part 1) \ \$31.00\$ \ F

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment
(1000 Volts Maximum)

NEMA AB 1 (1993) Molded Case Circuit Breakers and
Molded Case Switches

NEMA FU 1 (1986) Low Voltage Cartridge Fuses

NEMA ICS 1 (1993) Industrial Control and Systems

NEMA ICS 2 (1993) Industrial Controls and Systems
Controllers, Contactors, and Overload
Relays Rated Not More Than 2,000 Volts AC
or 750 Volts DC

NEMA ICS 3 (1993) Industrial Control and Systems
Factory Built Assemblies

NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA MG 1	(1998) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Polyphase Motors
NEMA OS 1	(1996) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA PB 1	(1995) Panelboards
NEMA RN 1	(1998) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(1992) Dry-Type Transformers for General Applications
NEMA TC 2	(1998) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)
NEMA WD 1	(1999) General Requirements for Wiring Devices
NEMA WD 6	(1997) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2000) Life Safety Code
NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(2000) Flexible Metal Conduit
UL 1004	(1994; Rev thru Nov 1999) Electric Motors
UL 198E	(1988; Rev Jul 1988) Class R Fuses
UL 20	(1995; Rev thru Oct 1998) General-Use Snap Switches
UL 360	(1996; Rev thru Oct 1997) Liquid-Tight Flexible Steel Conduit
UL 467	(1993; Rev thru Apr 1999) Grounding and Bonding Equipment
UL 486A	(1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486C	(1997; Rev thru Aug 1998) Splicing Wire

Connectors

UL 489	(1996; Rev thru Dec 1998) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 498	(1996; Rev thru Jan 1999) Attachment Plugs and Receptacles
UL 50	(1995; Rev thru Nov 1999) Enclosures for Electrical Equipment
UL 506	(1994; R Oct 1997) Specialty Transformers
UL 508	(1999) Industrial Control Equipment
UL 510	(1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 512	(1993; Rev thru Mar 1999) Fuseholders
UL 514A	(1996; Rev Dec 1999) Metallic Outlet Boxes
UL 514B	(1997; Rev Oct 1998) Fittings for Cable and Conduit
UL 6	(1997) Rigid Metal Conduit
UL 67	(1993; Rev thru Oct 1999) Panelboards
UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 83	(1998; Rev thru Sep 1999) Thermoplastic-Insulated Wires and Cables
UL 845	(1995; Rev thru Nov 1999) Motor Control Centers
UL 854	(1996; Rev Oct 1999) Service-Entrance Cables
UL 869A	(1998) Reference Standard for Service Equipment
UL 924	(1995; Rev thru Oct 97) Emergency Lighting and Power Equipment
UL 943	(1993; Rev thru May 1998) Ground-Fault Circuit-Interrupters
UL 98	(1994; Rev thru Jun 1998) Enclosed and Dead-Front Switches

1.2 GENERAL

1.2.1 Rules

The installation shall conform to the requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated or shown.

1.2.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible.

Lighting fixtures, outlets, and other equipment and materials shall be carefully coordinated with mechanical or structural features prior to installation and positioned according to architectural reflected ceiling plans; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate the electrical requirements of the mechanical work and provide all power related circuits, wiring, hardware and structural support, even if not shown on the drawings.

1.2.3 Special Environments

1.2.3.1 Damp and Weatherproof Locations

Wiring, Fixtures, and equipment in designated locations shall conform to NFPA 70 requirements for installation in damp or wet locations, regardless whether or not specifically shown or noted. All items located in the wet location, shall be in NEMA 4X enclosure, while items located in damp or interior spaces shall be NEMA 3R.

1.2.4 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.2.5 Nameplates

1.2.5.1 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with ASTM D 709 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the

supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4 inch
High Letters

Minimum 1/8 inch
High Letters

Panelboards
Starters
Safety Switches
Motor Control Centers
Transformers
Equipment Enclosures
Motors

Control Devices
Instrument Transformers

Each panel, section, or unit in motor control centers or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Interior Electrical Equipment; G.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission.

Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

- a. Motors and rotating machinery.
- b. Motor control centers.

SD-03 Product Data

Manufacturer's Catalog; G.

Data composed of catalog cuts, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material and Equipment; G.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

Installation Procedures; G.

Installation procedures for rotating equipment, transformers, panelboards, motor control centers. Procedures shall include necessary diagrams, instructions, and precautions required to install, adjust, calibrate, and test devices and equipment.

As-Built Drawings; G.

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction.

The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

Onsite Tests; G.

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-06 Test Reports

Factory Test Reports; G.

Six copies of the information described below in 8 1/2 x 11 inch

binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

Field Test Plan; G.

A detailed description of the Contractor's proposed procedures for onsite test submitted 14 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports; G.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.
- h. Final position of controls and device settings.

SD-07 Certificates

Materials and Equipment; G.

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of

this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1.4 WORKMANSHIP

Materials and equipment shall be installed in accordance with NFPA 70, recommendations of the manufacturer, and as shown.

PART 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.1 CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper. All conductors shall be copper.

2.1.1 Insulation

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN, THHN, or THW conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW, THW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.1.2 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.1.3 Service Entrance Cables

Service entrance (SE) and underground service entrance (USE) cables, UL 854.

2.2 CIRCUIT BREAKERS

2.2.1 MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489. Circuit breakers shall be installed in panelboards and motor control centers.

2.2.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper conductors only. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

2.2.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

2.3 CONDUIT AND TUBING

2.3.1 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797

2.3.2 Electrical Plastic Tubing and Conduit

NEMA TC 2.

2.3.3 Flexible Conduit, Steel

General-purpose type, UL 1; liquid tight and UL 360.

2.3.4 PVC Coated Rigid Steel Conduit

NEMA RN 1.

2.3.5 Rigid Aluminum Conduit

ANSI C80.5 and UL 6.

2.3.6 Rigid Metal Conduit

UL 6.

2.4 CONDUIT AND DEVICE BOXES AND FITTINGS

2.4.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514A.

2.4.2 Boxes, Switch (Enclosed), Surface-Mounted

UL 98.

2.4.3 Fittings for Conduit and Outlet Boxes

UL 514B.

2.5 CONNECTORS, WIRE PRESSURE

2.5.1 For Use With Copper Conductors

UL 486A.

2.6 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

2.6.1 Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

2.7 ENCLOSURES

NEMA ICS 6 or NEMA 250 locations, unless otherwise specified.

2.7.1 Cabinets and Boxes

Cabinets and boxes with volume greater than 100 cubic inches shall be in accordance with UL 50, hot-dip, zinc-coated, if sheet steel.

2.7.2 Circuit Breaker Enclosures

UL 489.

2.8 LOW-VOLTAGE FUSES AND FUSEHOLDERS

2.8.1 Fuses, Low Voltage Cartridge Type

NEMA FU 1.

2.8.2 Fuses, Class R

UL 198E.

2.8.3 Fuseholders

UL 512.

2.9 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

2.10 MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to NEMA MG 1 and UL 1004 for motors; NEMA MG 10 for energy management selection of polyphase motors. In addition to the standards listed above, motors shall be provided with efficiencies as specified in the table "MINIMUM NOMINAL EFFICIENCIES" below.

2.10.1 Rating

The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

2.10.2 Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motor efficiencies indicated in the tables apply to general-purpose, single-speed, polyphase induction motors. Applications which require definite purpose, special purpose, special frame, or special mounted polyphase induction motors are excluded from these efficiency requirements. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

MINIMUM NOMINAL MOTOR EFFICIENCIES
OPEN DRIP PROOF MOTORS

<u>HP</u>	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
1	82.5	85.5	80.0
1.5	86.5	86.5	85.5
2	87.5	86.5	86.5
3	89.5	89.5	86.5
5	89.5	89.5	89.5
7.5	91.7	91.0	89.5
10	91.7	91.7	90.2

TOTALLY ENCLOSED FAN-COOLED MOTORS

<u>HP</u>	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
1	82.5	85.5	78.5
1.5	87.5	86.5	85.5

2	88.5	86.5	86.5
3	89.5	89.5	88.5
5	89.5	89.5	89.5
7.5	91.7	91.7	91.0
10	91.7	91.7	91.7

2.11 MOTOR CONTROLS AND MOTOR CONTROL CENTERS

2.11.1 General

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845.

2.11.2 Motor Starters

Combination starters shall be provided with fusible switches, and switches equipped with high-interrupting-capacity current-limiting fuses.

2.11.3 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload and undervoltage protection in each ungrounded conductor. Each controller shall be provided with built-in protection against single phasing. In case of a phase failure, motor shall immediately automatically shutdown. The protection devices shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure next to the controller. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

2.11.4 Low-Voltage Motor Overload Relays

2.11.4.1 General

Thermal overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 seconds.

2.11.4.2 Construction

Manual reset type thermal relay shall be melting alloy construction. Automatic reset type thermal relays shall be bimetallic construction. Magnetic current relays shall consist of a contact mechanism and a dash pot mounted on a common frame.

2.11.4.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly

varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

2.11.5 Automatic Control Devices

2.11.5.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

2.11.5.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

2.11.5.3 Manual/Automatic Selection

- a. Where combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch (marked MANUAL-OFF-AUTOMATIC) shall be provided for the manual control.
- b. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.
- c. Connections to the selector switch shall be such that; only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

2.11.6 Motor Control Centers

Control centers shall conform to the requirements of NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845. Control centers shall be indoor type and shall contain combination starters and other equipment as indicated. Control centers shall be NEMA ICS 2, Class One, NEMA Type 3R. Each control center shall be mounted on floor sills or mounting channels. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Motor control centers shall be provided with copper bus bars and a full-length ground bus bar. The Motor Control Center shall be complete with required number, size and type of motor controllers, branch circuit breakers. Provide motor controllers full voltage either reversing or nonreversing type as specified or required with melting alloys, push button controls, start/stop/run indicated pilot lights and auxillary contacts for remote operation.

2.12 PANELBOARDS

Dead-front construction, NEMA PB 1 and UL 67.

2.13 RECEPTACLES

2.13.1 Hospital Grade

UL 498.

2.13.2 Ground Fault Interrupters

UL 943, Class A or B.

2.13.3 NEMA Standard Receptacle Configurations

NEMA WD 6. Duplex, 20-Ampere, 125 Volt

20-ampere, non-locking: NEMA type 5-20R.

2.14 Service Entrance Equipment

UL 869A.

2.15 SPLICE, CONDUCTOR

UL 486C.

2.16 SNAP SWITCHES

UL 20.

2.17 TAPES

2.17.1 Plastic Tape

UL 510.

2.17.2 Rubber Tape

UL 510.

2.18 TRANSFORMERS

Three-phase transformers shall have two windings per phase. Full-capacity standard NEMA taps shall be provided in the primary windings of transformers unless otherwise indicated. Three-phase transformers shall be configured with delta-wye windings. "T" connections may be used for transformers rated 15 kVA or below. Transformers supplying non-linear loads shall be UL listed as suitable for supplying such loads with a total K-factor not to exceed K-13 and have neutrals sized for 200 percent of rated current.

2.18.1 Transformers, Dry-Type

Transformers shall have 220 degrees C insulation system for transformers 15 kVA and greater with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient temperature of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying

continuously 100 percent of nameplate kVA without exceeding insulation rating.

a. 600 Volt or Less Primary:

NEMA ST 20, UL 506, general purpose, dry-type, self-cooled, sealed. Transformers shall be provided in NEMA 3R enclosure. Transformers shall be quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

2.19 WIRING DEVICES

NEMA WD 1 for wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

PART 3 EXECUTION

3.1 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following specifications.

3.1.1 Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, additional rods not less than 6 feet on centers may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

3.1.2 Grounding Conductors

A green equipment grounding conductor, sized in accordance with NFPA 70 shall be provided, regardless of the type of conduit and whether or not specifically indicated on the drawings. Equipment grounding bus bars shall be provided in all panelboards. The equipment grounding conductor shall be carried back to the service entrance equipment grounding connection. All equipment grounding conductors shall be bonded or joined together in each wiring box or equipment enclosure. Metallic raceways and grounding conductors shall be checked to assure that they are wired or bonded into a common junction. Metallic boxes and enclosures shall also be bonded to these grounding conductors by an approved means per NFPA 70.

3.2 WIRING METHODS

Wiring shall conform to NFPA 70, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit. Use rigid aluminum conduits only when specifically shown. Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified.

3.2.1 Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 3/4 inch. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by NFPA 70. Aluminum conduit may be used only where indicated. Raceways shall be kept 6 inches away from parallel runs of steam pipes and hot-water pipes. Raceways crossing structural expansion joints shall be provided with suitable expansion fittings or other suitable means to compensate for the structure expansion and contraction and to provide for continuity of grounding. Wiring installed in underfloor duct system shall be suitable for installation in wet locations.

3.2.1.1 Pull Wires

A pull wire shall be inserted in all empty raceways. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200 pounds per square inch tensile strength. Not less than 12 inches of slack shall be left at each end of the pull wire.

3.2.1.2 Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided. Lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment shall be prevented during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

3.2.1.3 Supports

Metallic conduits and the support system to which they are attached, shall be securely and rigidly fastened in place to prevent vertical and horizontal movement at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by expansion bolts on concrete, by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single

locknut and bushing may be used.

3.2.1.4 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Conduits shall be installed in accordance with NFPA 70 definitions.

3.2.1.5 Exposed Risers

Exposed risers in wire shafts of multistory buildings shall be supported by U-clamp hangers at each floor level, and at intervals not to exceed 10 feet.

3.2.1.6 Communications Raceways

Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and with the additional requirement that no length of run shall exceed 50 feet for 3/4 inch sizes, and 100 feet for 1 inch or larger sizes, and shall not contain more than two 90-degree bends or the equivalent. Additional pull or junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 1 inch size or larger shall not be less than ten times the nominal diameter.

3.2.2 Cables and Conductors

Installation shall conform to the requirements of NFPA 70. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

3.2.2.1 Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

3.2.2.2 Cable Systems

Cable systems shall be installed where indicated.

3.2.2.3 Cable Splicing

Splices shall be made in an accessible location. Crimping tools and dies shall be approved by the connector manufacturer for use with the type of connector and conductor.

- a. Copper Conductors, 600 Volt and Under: Splices in conductors No. 10 AWG and smaller diameter shall be made with an insulated, pressure-type connector. Splices in conductors No. 8 AWG and larger diameter shall be made with a solderless connector and insulated with tape or heat-shrink type insulating material

equivalent to the conductor insulation.

3.2.2.4 Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

- a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for 3-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).

277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).

- b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.
- c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate.

3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box. Boxes shall be listed for the intended use when located in normally wet locations. Boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Large size boxes shall be NEMA 3R or 4X as shown. Boxes shall be sheet steel except that aluminum boxes may be used with aluminum conduit.

3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened with bolts and metal expansion shields on concrete, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets.

3.3.3 Installation in Overhead Spaces

In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box.

3.4 DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel or cast-metal with rounded or beveled edges. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

3.5 RECEPTACLES

3.5.1 Duplex, 20-ampere, 125 volt

Single and duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Bodies shall be of ivory and supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Receptacles with ground fault circuit interrupters shall have the current rating as indicated, and shall be UL Class A type unless otherwise shown. Ground fault circuit protection shall be provided as required by NFPA 70.

3.5.2 Weatherproof Applications

Weatherproof receptacles shall be suitable for the wet location and the housings shall be labeled to identify the allowable use. Receptacles shall be marked in accordance with UL 514A for the type of use indicated; "Wet Locations", "When Cover Closed". Assemblies shall be installed in accordance with the manufacturer's recommendations.

3.5.2.1 Wet Locations

Receptacles in wet locations shall be installed in an assembly rated for such use whether the plug is inserted or withdrawn. In a duplex installation, the receptacle cover shall be configured to shield the connections whether one or both receptacles are in use.

3.6 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall be ivory. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than one switch shall be installed in a single-gang position. Switches shall be rated 20-ampere 120-volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be red.

3.7 SERVICE EQUIPMENT

Service-disconnecting means shall be of the type indicated with an external handle for manual operation. When service disconnecting means is a part of an assembly, the assembly shall be listed as suitable for service entrance equipment. Enclosures shall be sheet metal with hinged cover for surface mounting unless otherwise indicated.

3.8 PANELBOARDS

Circuit breakers used as a motor disconnecting means shall be capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be copper. Panelboards shall be circuit breaker equipped as indicated on the drawings. Circuit breakers shall be rated at 14,000 A.I.C. for 480 volt panelboards and 10,000 A.I.C. for 208 volt panelboards unless indicated otherwise.

3.9 FUSES

Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage.

3.9.1 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, time delay, Class RK1 or RK5 shall have tested interrupting capacity not less than 100,000 amperes.

3.10 UNDERGROUND SERVICE

Unless otherwise indicated, interior conduit systems shall be stubbed out 5 feet beyond the building wall and 2 feet below finished grade, for interface with the exterior service lateral conduits and exterior communications conduits. Outside conduit ends shall be bushed when used for direct burial service lateral conductors. Outside conduit ends shall be

capped or plugged until connected to exterior conduit systems. Underground service lateral conductors will be extended to building service entrance and terminated in accordance with the requirements outlined under the contract documents and NFPA 70. The underground conduits shall run minimum 36" below finished grade for power conduits and 24" for communication and control conduits.

3.11 MOTORS

Each motor shall conform to the hp and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Three-phase motors for use on 3-phase 208-volt systems shall have a nameplate rating of 460 volts and for use on 3-phase 480-volt systems shall have name plate rating of 208-volt. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. The Contractor shall be responsible for selecting the actual horsepower ratings and other motor requirements necessary for the applications indicated. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, conduit, disconnect switches, motor controllers, and branch-circuit protection to accommodate the equipment actually installed at no additional cost to the government.

3.12 MOTOR CONTROL

Each motor or group of motors requiring a single control and not controlled from a motor-control center shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector or transfer switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload

protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

3.12.1 Motor Control Centers

Control centers shall be indoor type and shall contain combination starters, circuit breakers and other equipment as indicated. Control centers shall be NEMA ICS 2, Class One, Type 3R. Each control center shall be mounted on floor sills or mounting channels. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Combination starters shall be provided with circuit breakers. Motor control centers shall be provided with a full-length ground bus bar.

3.12.2 Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

3.13 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

3.14 TRANSFORMER INSTALLATION

Three-phase transformers shall be connected only in a delta-wye configuration as indicated. "T" connections may be used for transformers rated at 15 kVA or below. Dry-type transformers shall be provided in a weatherproof enclosure.

3.15 LIGHTING FIXTURES, LAMPS AND BALLASTS

3.15.1 Emergency Light Sets

Provide self contained battery packs as indicated on the contract drawings. Emergency light sets shall conform to UL 924 with the number of heads as indicated. Sets shall be permanently connected to the wiring system by conductors installed in short lengths of flexible conduit.

3.16 EQUIPMENT CONNECTIONS

Wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided

with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

3.16.1 Motors and Motor Control

Motors, motor controls, and motor control centers shall be installed in accordance with NFPA 70, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated as per the requirements and recommendations of the equipment manufacturer.

3.17 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.

3.18 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 14 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3.18.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.18.2 Ground-Resistance Tests

The resistance of each grounding electrode shall be measured using the fall-of-potential method defined in IEEE Std 81. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements.

Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 25 ohms.

3.18.3 Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the

Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer 48 hours before the site is ready for inspection.

3.18.4 Metal Enclosed Bus Duct Tests

- a. Insulation Resistance phase-to-phase, all combinations.
- b. Insulation resistance phase-to-ground, each phase.
- c. AC or DC high-potential test.
- d. Phase rotation test.

3.18.5 Motor Tests

- a. Phase rotation test to ensure proper directions.
- b. Operation and sequence of reduced voltage starters.
- c. High potential test on each winding to ground.
- d. Insulation resistance of each winding to ground.
- e. Vibration test.

3.18.6 Dry-Type Transformer Tests

The following field tests shall be performed on all dry-type transformers.

- a. Insulation resistance test phase-to-ground, each phase.
- b. Turns ratio test.

3.18.7 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers.

3.18.7.1 Circuit Breakers, Molded Case

- a. Insulation resistance test phase-to-phase, all combinations.
- b. Insulation resistance test phase-to-ground, each phase.
- c. Closed breaker contact resistance test.
- d. Manual operation of the breaker.

3.18.8 Motor Control Centers

- a. Insulation resistance test phase-to-phase, all combinations.
- b. Insulation resistance test phase-to-ground, each phase.
- c. Manual and electrical operational tests.

3.18.9 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published

instructions. These tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to insure proper calibration and operation. Relay settings shall be implemented in accordance with the coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.

3.19 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

3.20 FIELD SERVICE

3.20.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations.

3.20.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

3.21 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

SECTION 16751

CLOSED CIRCUIT TELEVISION SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 170	(1957) Electrical Performance Standards - Monochrome Television Studio Facilities
EIA ANSI/EIA/TIA-232-F	(2002) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
EIA ANSI/EIA-310-D	(1992) Racks, Panels, and Associated Equipment
EIA ANSI/EIA-375-A	(1974) Direct View Monochrome Closed Circuit Television Monitors 525/60 Interlaced 2:1

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2002) National Electrical Safety Code
IEEE Std 142	(199) Recommended Practice for Grounding of Industrial and Commercial Power Systems - Green Book

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
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U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices
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1.2 SYSTEM DESCRIPTION

1.2.1 General

The Contractor shall configure the system as described and shown. All television equipment shall conform to EIA 170 specifications. The system

shall include all connectors, adapters, and terminators necessary to interconnect all equipment. The Contractor shall also supply all cabling necessary to interconnect the closed circuit television (CCTV) equipment installed at remote control/monitoring stations.

1.2.2 Video and Sync Signal Transmission Line Surge Protection

All cable, except fiber optic cable, used for sync or video signal transmission shall include protective devices to safeguard the CCTV equipment against surges. The surge suppression device shall not attenuate or reduce the video or sync signal under normal conditions. The surge suppression device shall be capable of dissipating not less than 1500 watts for 1 millisecond, and the response time from zero volts to clamping shall not be greater than 5 nanoseconds. Fuses shall not be used for surge protection.

1.2.3 Video and Control Signal Data Transmission Media

The Contractor shall provide a video and control signal transmission system as specified in Sections 13801 and 16792.

1.2.4 Environmental Conditions

1.2.4.1 Field Equipment

The cameras and all other field equipment shall be rated for continuous operation under ambient environmental conditions of -20 degrees to 120 degrees F using auxiliary heating. Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, wind loading, ice loading, and vibration conditions specified or encountered for the installed location.

1.2.4.2 Control Equipment

Remote control/monitoring station equipment shall, unless designated otherwise, be rated for continuous operation under ambient environmental conditions of 60 degrees F to 85 degrees F and a relative humidity of 20 to 80 percent.

1.2.5 Electrical Requirements

Electrically powered IDS equipment shall operate on 120 volt 60 Hz AC sources as shown. Equipment shall be able to tolerate variations in the voltage source of plus or minus 10 percent, and variations in the line frequency of plus or minus 2 percent with no degradation of performance.

1.3 DELIVERY OF TECHNICAL DATA AND COMPUTER SOFTWARE

1.3.1 Group I Technical Data Package

1.3.1.1 System Drawings

The data package shall include the following:

- a. System block diagram.
- b. CCTV control equipment installation, interconnection with console equipment, block diagrams and wiring diagrams.

- c. Camera wiring and installation drawings.
- d. Pan/tilt/zoom (PTZ) mount wiring and installation drawings.
- e. Interconnection with video signal transmission system, block diagrams and wiring diagrams.
- f. Surge protection device installation.

1.3.1.2 Manufacturers' Data

The data package shall include manufacturers' data for all materials and equipment.

1.3.1.3 System Description and Analyses

The data package shall include complete system descriptions, analyses and calculations used in sizing the equipment required by these specifications. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance of this specification. The data package shall include the following:

- a. Switcher size.
- b. Camera call-up response time.
- c. System start up and shutdown operations.
- d. Switcher programming instructions.
- e. Switcher operating and maintenance instructions.
- f. Manuals for CCTV equipment.
- g. Data entry forms.

1.3.1.4 Software Data

The data package shall consist of descriptions of the operation and capability of system and application software as specified.

1.3.1.5 Overall System Reliability Calculations

The data package shall include all manufacturer's reliability data and calculations required to show compliance with the specified reliability. The calculations shall be based on all CCTV equipment associated with one camera circuit and the console CCTV equipment, excluding the data transmission media (DTM).

1.3.1.6 Certifications

All specified manufacturer's certifications shall be included with the data package.

1.3.2 Group II Technical Data Package

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall submit a report to the Government documenting changes to the site, or conditions that affect performance of

the system to be installed. For those changes or conditions which affect system installation or performance, provide (with the report) specification sheets, or written functional requirements to support the findings, and a cost estimate to correct the deficiency. The Contractor shall not correct any deficiency without written permission from the Government.

1.3.3 Group IV Technical Data Package

The Contractor shall prepare test procedures and reports for the performance verification test and the endurance test. The Contractor shall deliver the performance verification test and endurance test procedures to the Government for approval. After receipt by the Contractor of written approval of the test procedures, the Contractor may schedule the tests. The contractor shall provide a report detailing the results of the field test and a video tape as specified in paragraph "Contractor's Field Testing." The final performance verification and endurance test report shall be delivered after completion of the tests.

1.3.3.1 Operation and Maintenance Manuals

A draft copy of the operation and maintenance manuals, as specified for the Group V technical data package, shall be delivered to the Government prior to beginning the performance verification test for use during site testing.

1.3.3.2 Graphics

Where graphics are required and are to be delivered with the system, the Contractor shall create and install all graphics needed to make the system operational. Graphics shall have sufficient level of detail for the system operator to assess the alarm. The Contractor shall supply hard copy, color examples at least 8 by 10 inches in size, of each type of graphic to be used for the completed CCTV system. If the video switcher does not use a monitor for display of system information, the Contractor shall provide examples of the video annotation used for camera identification. The graphics examples shall be delivered to the Government for review and approval at least 90 days prior to the Contractor's scheduled need date.

1.3.4 Group V Technical Data Package

Final copies of each of the manufacturer's commercial manuals arranged as specified bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. The number of copies of each manual to be delivered shall be as specified on DD Form 1423.

1.3.4.1 Hardware Manual

- a. System setup procedures.

1.3.4.2 Operator's Manual

- a. Video switcher.
- b. Cameras and video recording equipment.
- c. Use of the software.

1.3.4.3 Maintenance Manual

The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.4 TRAINING

1.4.1 Operator's Training I

- a. General CCTV hardware, installed system architecture and configuration.
- b. Alarm interfaces.
- c. Fault diagnostics and correction.

1.5 MAINTENANCE AND SERVICE

1.5.1 Description of Work

The adjustment and repair of the CCTV system includes all computer equipment, software updates, signal transmission equipment, and video equipment. Provide the manufacturer's required adjustments and all other work necessary.

1.5.2 Personnel

Service personnel shall be qualified to accomplish all work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

1.5.3 Schedule of Work

The Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:

- a. Visual checks and operational tests of the CPU, switcher, peripheral equipment, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera.
- b. Run system software and correct all diagnosed problems.
- c. Resolve any previous outstanding problems.

1.5.4 Emergency Service

The Government will initiate service calls when the CCTV system is not functioning properly. Qualified personnel shall be available to provide

service to the complete CCTV system. The Government shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at the site within 24 hours after receiving a request for service. The CCTV system shall be restored to proper operating condition within 3 calendar days after receiving a request for service.

1.5.5 Operation

Performance of scheduled adjustments and repair shall verify operation of the CCTV system as demonstrated by the applicable portions of the performance verification test.

1.5.6 Records and Logs

The Contractor shall keep records and logs of each task, and shall organize cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain calibration, repair, and programming data. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the CCTV system.

1.5.7 Work Requests

The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is completed.

1.5.8 System Modifications

The Contractor shall make any recommendations for system modification in writing to the Government. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Government. Any modifications made to the systems shall be incorporated into the operations and maintenance manuals, and other documentation affected.

1.5.9 Software

The Contractor shall recommend all software updates to the Government for approval. Upon Government approval, updates shall be accomplished in a timely manner, fully coordinated with the CCTV system operators, operation in the system verified, and shall be incorporated into the operations and maintenance manuals, and software documentation. There shall be at least one scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the manufacturer's software.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

All system hardware and software components shall be produced by

manufacturers regularly engaged in the production of CCTV equipment. Units of the same type of equipment shall be products of a single manufacturer. All material and equipment shall be new and currently in production. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Equipment located at the security center or a remote control/monitoring station shall be rack mounted as shown. Both Television and Computing devices shall comply with 47 CFR 15, Subpart B.

2.1.1 Fungus Treatment

System components located in fungus growth inductive environments shall be completely treated for fungus resistance. Treating materials containing a mercury bearing fungicide shall not be used. Treating materials shall not increase the flammability of the component or surface being treated. Treating materials shall not cause skin irritation or other injury to personnel handling it during fabrication, transportation, operation, maintenance, or during the use of the finished items when used for the purpose intended.

2.1.2 Soldering

All soldering shall be done in accordance with standard industry practices.

2.2 ENCLOSURES

The Contractor shall provide metallic enclosures as needed for equipment not housed in racks or supplied with a housing. The enclosures shall be as specified or shown.

2.2.1 Exposed-to-Weather

Enclosures to house equipment in an outdoor environment shall meet the requirements of NEMA 250 Type 4X.

2.2.2 Corrosion-Resistant

Enclosures to house equipment in a corrosive environment shall meet the requirements of NEMA 250 Type 4X.

2.3 TAMPER PROVISIONS

2.3.1 Conduit-Enclosure Connections

All conduit-enclosure connections shall be protected by tack welding or brazing the conduit to the enclosure. Tack welding or brazing shall be done in addition to standard conduit-enclosure connection methods as described in NFPA 70.

2.4 LOCKS AND KEY-LOCK OPERATED SWITCHES

2.4.1 Locks

Locks shall be provided on system enclosures for maintenance purposes shall be UL listed, round-key type, with three dual, one mushroom, and three plain pin tumblers or conventional key type lock having a combination of five cylinder pin and five-point three position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." The locks shall be so arranged that the key can only be withdrawn when in the locked position. All maintenance

locks shall be keyed alike and only two keys shall be furnished for all of these locks.

2.4.2 Key-Lock-Operated Switches

All key-lock-operated switches required to be installed on system components shall be UL listed, with three dual, one mushroom, and three plain pin tumblers, or conventional key type lock having a combination of five cylinder pin and five-point three position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." Key-lock-operated switches shall be two position, with the key removable in either position. All key-lock-operated switches shall be keyed differently and only two keys shall be furnished for each key-lock-operated-switch.

2.5 SOLID STATE CAMERAS

2.5.1 High Resolution Color Camera

All electronic components and circuits shall be solid state. Signal-to-noise ratio shall not be less than 50 dB unweighted. The camera shall exhibit no geometric distortion. The lens mount shall be a C-mount, and the camera shall have a back focus adjustment. The camera shall operate from 14 to 131 degrees F without auxiliary heating or cooling, and with no change in picture quality or resolution. The camera shall operate on 60 Hz AC power, and shall be capable of operating at a voltage of 24 Volts.

2.5.1.1 Solid State Image Array

The camera shall have a solid state imaging array, and the picture produced by the camera shall be free of blemishes as defined by EIA 330. The camera shall provide not less than 460 lines of horizontal resolution, and resolution shall not vary over the life of the camera. The imager shall have at least 768 horizontal x 494 vertical active picture elements.

2.5.1.2 Sensitivity

Camera shall provide full video output with the infrared cut-off filter installed, without camera automatic gain, and a scene reflectivity of 75 percent using an f/1.2 lens given a camera faceplate illumination at 3200K of 0.2 footcandle minimum.

2.5.1.3 Camera Synchronization

The camera shall have an input for external sync, and shall automatically switch over to internal sync if external sync is not present. The camera shall also have the capability of synchronization by line-locking to the AC power line frequency at the zero crossing point, and shall provide not less than plus or minus 90 degrees of vertical phase adjustment.

2.5.1.4 Connectors

Cameras with lenses having auto iris, manual iris, or zoom and focus functions shall be supplied with connectors and wiring as needed to operate the lens functions. Video signal output connector shall be a BNC. Cameras with integral fiber optic video transmitters shall have straight-tip bayonet type fiber optic video output connectors. A connector shall be provided for external sync input.

2.5.1.5 Automatic Circuits

The camera shall have circuitry for through the lens (TTL) white balancing, fixed white balancing, and automatic gain control.

2.5.2 Dome Cameras

2.5.2.1 Exterior Dome Camera System

An exterior dome camera system shall be provided with integral camera installed and integrated into the dome housing. The camera shall have a minimum horizontal resolution of 425 lines (color). The dome housing shall be nominally 6 inches and shall be furnished in a NEMA 4X, pole mount. The housing shall be constructed to be dust and water tight, and fully operational in 100 percent condensing humidity. The housing shall be equipped with supplementary camera mounting blocks or supports as needed to position the specified camera and lens to maintain the proper optical centerline. All electrical and signal connections required for operation of the camera and lens shall be supplied. The housing shall protect the internal drives, positioners, and camera from the environment encountered for camera operation. The lower dome shall be tinted acrylic and shall have a light attenuation factor of not more than 1 f-stop. An integral heater, sized to maintain the lower dome above the dew point, shall be part of the camera system. The housing shall be equipped with integral pan/tilt/zoom complete with wiring, wiring harnesses, connectors, receiver/driver, pan/tilt/zoom control system, pre-position cards, or any other hardware and equipment as needed to provide a fully functional pan/tilt/zoom dome. The pan/tilt/zoom shall have heavy duty bearings and hardened steel gears. The pan/tilt/zoom shall be permanently lubricated. The motors shall be thermally or impedance protected against overload damage. Pan movement shall be 360 degrees and tilt movement shall not be less than plus and minus 90 degrees. Pan speed shall not be less than 20 degrees per second, and tilt speed shall not be less than 10 degrees per second. There shall not be less than 99 preset positions, with positioning speeds of at least 360 degrees per second in the automatic mode, and not less than 120 degrees per second in the manual positioning mode, with a positioning accuracy of plus or minus 1/2 degree. Each set of preset position data shall include auto focus, auto iris, pan, tilt, and zoom functions. The system shall be able to automatically scan between any two electronically-set limits, and shall be able to operate in the "tour" mode covering up to all presets in a user defined sequence. The dome system shall withstand temperature ranges from minus 20 to 122 degrees F over a humidity range of 0 to 90 percent, non-condensing.

2.6 CAMERA LENSES

Camera lenses shall be all glass with coated optics. The lens mount shall be a C or CS mount, compatible with the cameras selected. The lens shall be supplied with the camera, and shall have a maximum f-stop opening of f/1.2 or the maximum available for the focal length specified. The lens shall be equipped with an auto-iris mechanism unless otherwise specified. Lenses having auto iris, manual iris, or zoom and focus functions shall be supplied with connectors, wiring, receiver/drivers, and controls as needed to operate the lens functions. Lenses shall have sufficient circle of illumination to cover the image sensor evenly. Lenses shall not be used on a camera with an image format larger than the lens is designed to cover. Lens focal lengths shall be as shown or specified in the manufacturer's lens selection tables.

2.7 VIDEO MONITOR

2.7.1 Color Video Monitor

All electronic components and circuits shall be solid state except for the picture tube. The monitor shall have a stabilized high voltage power supply, and regulated low voltage power supplies. The monitor shall have automatic frequency control (AFC) and horizontal resolution not less than 280 lines at the center of the picture tube. The video input shall allow switchable loop-through or 75 ohm termination. The monitor shall have circuitry for automatic degaussing. The monitor shall operate on 60 Hz AC power, and shall be capable of operating at a voltage of 120 Volts.

2.7.2 Picture Tube

The monitor shall have a 13 inch picture tube measured diagonally.

2.7.3 Configuration

The monitor shall be configured in a cabinet or mount. Monitors shall not interfere with each other when rack mounted or operated next to each other as described in EIA ANSI/EIA-375-A.

2.7.4 Controls

Front panel controls shall be provided for power on/off, horizontal hold, vertical hold, contrast, and brightness. The monitor shall have switchable DC restoration.

2.7.5 Connectors for Video Monitor

Video signal input and output shall be by BNC connectors.

2.8 VIDEO SWITCHER

The switcher shall conform to EIA 170 specifications, and shall be a vertical interval switcher. Electronic components, subassemblies, and circuits of the switcher shall be solid state. The switcher shall be microprocessor based and software programmable. The switcher shall be a modular system that shall allow for expansion or modification of inputs, outputs, alarm interfaces, and secondary control stations by addition of the appropriate modules. Switcher components shall operate on 120 volts 60 Hz AC power. The video switcher central processing unit (CPU) shall have the capability of accepting time from a master clock supplied in ASCII format through an EIA ANSI/EIA/TIA-232-F input. All components, modules, cables, power supplies, software, and other items needed for a complete and operable CCTV switching system shall be provided. Switcher equipment shall be rack mounted unless otherwise specified. Rack mount hardware shall be supplied to mount the switcher components in a standard 19 inch rack as described in EIA ANSI/EIA-310-D.

2.8.1 Switcher Modular Expansion

The switcher shall be expandable in minimum increments as specified below.

2.8.1.1 Input Module

Hardware expansion modules shall be provided to expand the switcher matrix configuration in increments of at least 8 camera inputs.

2.8.1.2 Output Module

Hardware expansion modules shall be provided to expand the switcher matrix configuration in increments of at least 4 video outputs.

2.8.2 Control Keyboards

Control and programming keyboards shall be supplied for the video switcher at the security center, and control keyboards shall be supplied for any control/monitoring stations as shown. The control keyboard shall provide the interface between the operator and the CCTV system, and shall relay commands from the operator to the switcher CPU. The keyboard shall provide control of the video switcher functions needed for operation and programming of the video switcher. Controls shall include, but not be limited to: programming the switcher, switcher control, lens function control, pan/tilt/zoom (PTZ) control, control of environmental housing accessories, and annotation programming. If the switcher CPU requires an additional text keyboard for system management functions, the keyboard shall be supplied as part of the video switcher.

2.8.3 Accessory Control Equipment

The video switcher shall be equipped with signal distribution units, preposition cards, expansion units, cables, software or any other equipment needed to ensure that the CCTV system is complete and fully operational.

2.8.4 Connectors for Video Switcher

Video signal input and output shall be by BNC connectors.

2.8.5 Video Annotation

Video annotation equipment shall be provided for the video switcher. The annotation shall be alphanumeric and programmable for each video source. Annotation to be generated shall include, but not be limited to: individual video source identification number, time (hour, minute, second) in a 24 hour format, date (month, day, year), and a unique, user-defined title with at least 8 characters. The annotation shall be inserted onto the source video so that both shall appear on a monitor or recording. The lines of annotation shall be movable for horizontal and vertical placement on the video picture. The annotation shall be automatically adjusted for date. Programmed annotation information shall be retained in memory for at least 4 hours in the event of power loss.

2.9 VIDEO CASSETTE RECORDER (VCR)

VCR shall conform to EIA 170 standards. The VCR shall be specifically designed as a time lapse recorder for use in security systems. The VCR shall operate on 120 volts 60 Hz AC power. Resolution of the VCR in normal play mode shall not be less than 350 horizontal lines in monochrome, 300 horizontal lines in color. Signal-to-noise ratio shall not be less than 40 dB. The VCR shall have a condensation or dew circuit. The VCR shall have a built-in time and date generator that can be turned on or off, and shall impose the time and date on the video during recording. A 24 hour battery back-up shall be provided to protect time/date and programmed information. The VCR shall have an audible warning alarm that shall annunciate the end of tape, excessive condensation, tape transport malfunction, or tape jam.

2.9.1 Tape and Tape Transport

The video tape used in the recorder shall be contained in a cassette mechanism, and shall not require the operator to thread the tape through the tape transport mechanism. The tape shall load through the front of the recorder.

2.9.2 Recording and Playback

The VCR shall be capable of recording for 168 hours or more on a single cassette tape with at least 6 user selectable time-lapse record speeds. The VCR shall have a contact closure alarm signal input which shall automatically switch the recorder into standard play, record mode when an alarm is initiated. The recorder shall reach stabilized record speed in 1 second or less. The VCR shall put a cue mark on the tape at the beginning of an alarm event recording. The alarm event record time shall be selectable for up to 3 minutes of automatic recording as a minimum. A record-lock feature shall be provided which shall protect the VCR against tampering with the tape transport controls and power control once recording has started. Playback functions shall include: alarm search, fast forward search, fast rewind search, rewind/fast forward, play, slow motion or step field/frame, and pause/still.

2.9.3 Connectors for VCR

Video signal input and output shall be by BNC connectors. The recorder shall provide connectors for alarm trigger signal input and output.

2.10 CCTV CAMERA POLES

2.10.1 Pan/Tilt Mounting Pole

The pan/tilt mounting pole shall be a straight aluminum pole. The pole shall be 20 feet high and shall have a mounting plate at the top for the pan/tilt. The pole and mounting plate shall have a corrosion-resistant finish. The mounting plate shall have a bolt hole pattern to match the base of the pan/tilt to be mounted on the pole. Under maximum loading, the total pole deflection shall not exceed 0.1 of one degree. A cable conduit shall be provided from the base of the pole to the mounting plate of the pan/tilt. The conduit shall be sized to accommodate all wiring needed for the camera and pan/tilt.

2.11 ACCESSORIES

Standard 19 inch electronic rack cabinets conforming to EIA ANSI/EIA-310-D shall be provided for the CCTV system.

2.12 WIRE AND CABLE

The Contractor shall provide all wire and cable not indicated as Government Furnished Equipment. All wire and cable components shall be able to withstand the environment the wire or cable is installed in for a minimum of 20 years.

2.12.1 CCTV Equipment Video Signal Wiring

The coaxial cable shall have a characteristic impedance of 75 ohms plus or minus 3 ohms. RG 59/U coaxial signal cable shall have shielding which provides a minimum of 95 percent coverage, a solid copper center conductor

of not less than 23 AWG, polyethylene insulation, and a black non-contaminating polyvinylchloride (PVC) jacket. RG 6/U coaxial cable shall have shielding which provides a minimum of 95 percent coverage, with center conductor of 18 AWG or larger polyethylene insulation, and a black non-contaminating polyvinylchloride (PVC) jacket.

2.12.2 Low Voltage Control Wiring

Twisted pair low voltage control wiring to be used above ground or as direct burial cable shall be provided. Plenum or riser cables shall be IEEE C2 CL2P certified.

2.12.3 Digital Data Interconnection Wiring

Interconnecting cables carrying digital data between equipment located at the main control room shall be not less than 20 AWG and shall be stranded copper wire for each conductor. The cable or each individual conductor within the cable shall have a shield that provides 100 percent coverage. Cables with a single overall shield shall have a tinned copper shield drain wire. Plenum or riser cables shall be IEEE C2 CL2P certified.

2.13 PREDELIVERY TESTING

2.13.1 General

The Contractor shall assemble the test CCTV system as specified, and perform tests to demonstrate that the performance of the system complies with the contract requirements in accordance with the approved predelivery test procedures. The tests shall take place during regular daytime working hours on weekdays. Model numbers of equipment tested shall be identical to those to be delivered to the site. Original copies of all data produced during predelivery testing, including results of each test procedure, shall be delivered to the Government at the conclusion of predelivery testing prior to Government approval of the test. The test report shall be arranged so that all commands, stimuli, and responses are correlated to allow logical interpretation.

2.13.2 Test Setup

The Contractor shall provide the equipment needed for the test setup and shall configure it to provide alarm actuated camera call-up and alarm recording as required to emulate the installed system. The test setup shall consist of at least 1 complete camera circuits. The alarm signal input to the CCTV test setup shall be by the same method that is used in the installed system. The video switcher shall be capable of switching any camera to any monitor and any combination of cameras to any combination of monitors. The minimum test setup shall include:

- a. One video cameras and lenses, including dome cameras if required for the installed system.
- b. Two video monitors.
- c. Video recorder if it is required for the installed system.
- d. Video switcher including video input modules, video output modules, and control and applications software.
- e. Pan/tilt mount and pan/tilt controller if the installed system

includes cameras on pan/tilt mounts.

f. Any ancillary equipment associated with a camera circuit such as video loss/presence detectors, terminators, ground loop correctors, surge protectors or other in-line video devices.

g. Cabling for all components.

PART 3 EXECUTION

3.1 INSTALLATION

The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2 and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system. Raceways shall be furnished and installed as specified in Section 16415 ELECTRICAL WORK, INTERIOR. DTM shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring. All other electrical work shall be as specified in the above section including grounding to preclude ground loops, noise, and surges from adversely affecting system operation.

3.1.1 Current Site Conditions

The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Government in a report. The Contractor shall not take any corrective action without written permission from the Government.

3.1.2 Enclosure Penetrations

All enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

3.1.3 Cold Galvanizing

All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

3.1.4 Interconnection of Console Video Equipment

The Contractor shall connect signal paths between video equipment with RG-6/U coaxial cable. Cables shall be as short as practicable for each signal path without causing strain at the connectors. Rack mounted equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the rack.

3.1.5 Cameras

The Contractor shall install the cameras with the proper focal length lens as indicated for each zone; connect power and signal lines to the camera; set cameras with fixed iris lenses to the proper f-stop to give full video level; aim camera to give field of view as needed to cover the alarm zone; aim fixed mount cameras installed outdoors facing the rising or setting sun sufficiently below the horizon to preclude the camera looking directly at the sun; focus the lens to give a sharp picture over the entire field of view; and synchronize all cameras so the picture does not roll on the monitor when cameras are selected. Dome cameras shall have all preset positions defined and installed.

3.1.6 Monitors

The Contractor shall install the monitors as shown and specified; connect all signal inputs and outputs as shown and specified; terminate video input signals as required; and connect the monitor to AC power.

3.1.7 Switcher

The Contractor shall install the switcher as shown and according to manufacturer's instructions; connect all subassemblies as specified by the manufacturer and as shown; connect video signal inputs and outputs as shown and specified; terminate video inputs as required; connect alarm signal inputs and outputs as shown and specified; connect control signal inputs and outputs for ancillary equipment or secondary control/monitoring sites as specified by the manufacturer and as shown; connect the switcher CPU and switcher subassemblies to AC power; load all software as specified and required for an operational CCTV system configured for the site requirements, including data bases, operational parameters, and system, command, and application programs; provide the original and 2 backup copies for all accepted software upon successful completion of the endurance test; and program the video annotation for each camera.

3.1.8 Video Recording Equipment

The Contractor shall install the video recording equipment as shown and as specified by the manufacturer; connect video signal inputs and outputs as shown and specified; connect alarm signal inputs and outputs as shown and specified; and connect video recording equipment to AC power.

3.1.9 Camera Housings, Mounts, and Poles

The Contractor shall install the camera housings and mounts as specified by the manufacturer and as shown, provide mounting hardware sized appropriately to secure each camera, housing and mount with maximum wind and ice loading encountered at the site; provide a foundation for each camera pole as specified and shown; provide a ground rod for each camera pole and connect the camera pole to the ground rod as specified in Section 16050; provide electrical and signal transmission cabling to the mount location as specified in Section 16050; connect signal lines and AC power to mount interfaces; and connect pole wiring harness to camera.

3.2 SYSTEM STARTUP

The Contractor shall not apply power to the CCTV system until the following items have been completed:

- a. CCTV system equipment items and DTM have been set up in accordance with manufacturer's instructions.
- b. A visual inspection of the CCTV system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
- c. System wiring has been tested and verified as correctly connected as indicated.
- d. All system grounding and transient protection systems have been verified as properly installed and connected as indicated.
- e. Power supplies to be connected to the CCTV system have been verified as the correct voltage, phasing, and frequency as indicated.
- f. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work/equipment.

3.3 SUPPLEMENTAL CONTRACTOR QUALITY CONTROL

The following requirements supplement the contractor quality control requirements specified elsewhere in the contract. The contractor shall provide the services of technical representatives who are thoroughly familiar with all components and installation procedures of the installed IDS; and are approved by the Contracting Officer. These representatives will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance. These representatives shall also be available on an as needed basis to provide assistance with follow-up phases of quality control. These technical representatives shall participate in the testing and validation of the system and shall provide certification that their respective system portions meet its contractual requirements.

3.4 SITE TESTING

3.4.1 Contractor's Field Testing

The Contractor shall calibrate and test all equipment, verify DTM operation, place the integrated system in service, and test the integrated system. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure. In addition, the Contractor shall make a master video tape recording showing typical day and night views of each camera in the system and shall deliver the tape with the report. Note any objects in the field of view that might produce highlights that could cause camera blinding. Note any objects in the field of view or anomalies in the terrain which may cause blind spots. Note if a camera cannot be aimed to cover the zone and exclude the rising or setting sun from the picture. Note night assessment capabilities and whether lights or vehicle headlights cause blooming or picture degradation. If any of the above conditions or other conditions exist that cause picture

degradation or interfere with the camera field of view, the Contractor shall inform the Contracting Officer. The tape shall be recorded using the video recorder installed as part of the CCTV system. If a recorder is not part of the CCTV system, the Contractor shall provide the tape in Video Home System (VHS) format. The Contractor shall provide the Government with the original tape as part of the documentation of the system and shall submit a letter certifying that the CCTV system is ready for performance verification testing. The field testing shall as a minimum include:

- a. Verification that the video transmission system and any signal or control cabling have been installed, tested, and approved as specified.
- b. When the system includes remote control/monitoring stations or remote switch panels, verification that the remote devices are functional, communicate with the main control, and perform all functions as specified.
- c. Verification that the switcher is fully functional and that the switcher software has been programmed as needed for the site configuration.
- d. Verification that switcher software is functioning correctly. All software functions shall be exercised.
- e. Operation of all electrical and mechanical switcher controls and verification that the control performs the designed function.
- f. Verification that all video sources and video outputs provide a full bandwidth signal that complies with EIA 170 at all video inputs.
- g. Verification that all video signals are terminated properly.
- h. Verification that all cameras are aimed and focused properly. The Contractor shall conduct a walk test of the area covered by each camera to verify the field of view.
- i. Verification that cameras facing the direction of rising or setting sun are aimed sufficiently below the horizon so that the camera does not view the sun directly.
- j. If vehicles are used in proximity of the assessment areas, verification of night assessment capabilities and determination if headlights cause blooming or picture degradation.
- k. Verification that all cameras are synchronized and that the picture does not roll when cameras are switched.
- l. When pan/tilt mounts are used in the system, verification that the limit stops have been set correctly. Verification of all controls for pan/tilt/zoom mechanisms are operative and that the controls perform the desired function. If preposition controls are used, verification that all home positions have been set correctly, and have been tested for auto home function and correct home position.
- m. When dome camera mounts are used in the system, verify that all preset positions are correct and that the dome also operates correctly in a manual control mode.

The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

3.4.2 Performance Verification Test

The Contractor shall demonstrate that the completed CCTV system complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test, as specified, shall not be started until receipt by the Contractor of written permission from the Government, based on the Contractor's written report. This shall include certification of successful completion of Contractor Field Testing as specified in paragraph "Contractor's Field Testing," and upon successful completion of training as specified. The Government may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Endurance Testing Phase II. Upon successful completion of the performance verification test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to commencing the endurance test.

-- End of Section --

SECTION 16768

FIBER OPTIC DATA TRANSMISSION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 170	(1957) Electrical Performance Standards - Monochrome Television Studio Facilities
EIA ANSI/EIA/TIA-232-F	(2002) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
EIA ANSI/TIA/EIA-455-13A	(2002) FOTP-13 Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies
EIA ANSI/EIA/TIA-455-25C	(2002) FOTP-25 Impact Testing of Optical Fiber Cables
EIA ANSI/EIA/TIA-455-30B	(1991) FOTP-30 Frequency Domain Measurement of Multimode Optical Fiber Information Transmission Capacity
EIA ANSI/TIA/EIA-455-41A	(2001) FOTP-41 Compressive Loading Resistance of Fiber Optic Cables
EIA ANSI/EIA/TIA-455-46A	(1990) FOTP-46 Spectral Attenuation Measurement for Long-Length, Graded-Index Optical Fibers
EIA ANSI/EIA/TIA-455-47B	(1992) FOTP-47 Output Far Field Radiation Pattern Measurement
EIA ANSI/EIA/TIA-455-58B	(2001) FOTP-58 Core Diameter Measurement of Graded-Index Optical Fibers
EIA ANSI/EIA/TIA-455-59A	(2000) FOTP-59 Measurement of Fiber Point Defects Using an OTDR
EIA ANSI/EIA/TIA-455-61A	(2000) FOTP-61 Measurement of Fiber or Cable Attenuation Using an OTDR
EIA ANSI/EIA-455-81A-91	(1992) FOTP-81 Compound Flow (Drip) Test for Filled Fiber Optic Cable
EIA ANSI/EIA/TIA-455-82B	(1992) FOTP-82 Fluid Penetration Test for

Fluid-Blocked Fiber Optic Cable

EIA-455-88	(2001) FOTP-88 Fiber Optic Cable Bend Test
EIA ANSI/EIA-455-91	(1986; R 1996) FOTP-91 Fiber Optic Cable Twist-Bend Test
EIA TIA/EIA-455-104A	(2000) FOTP-104 Fiber Optic Cable Cyclic Flexing Test
EIA ANSI/EIA-455-171	(1987) FOTP-171 Attenuation by Substitution Measurement - for Short-Length Multimode Graded-Index and Single-Mode Optical Fiber Cable Assemblies
EIA ANSI/TIA/EIA-455-177A	(1992) FOTP-177 Numerical Aperture Measurement of Graded-Index Optical Fibers
EIA ANSI/TIA/EIA-485-A	(1998) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems
EIA ANSI/TIA/EIA-606A	(2002) Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 volts Maximum)
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
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UNDERWRITERS LABORATORIES (UL)

UL 910	(1998) Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air
UL 1666	(2000) Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices
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1.2 SYSTEM DESCRIPTION

1.2.1 General

A fiber optics (FO) data transmission system (DTS) shall be provided. The data transmission system shall consist of fiber optic transmission media, transmitter and receiver modules, FO modems, transceiver modules, repeaters, power line surge protection and terminal devices (such as connectors, patch panels and breakout boxes). The data transmission system shall interconnect system components as shown. Computing devices, as defined in 47 CFR 15, shall be certified to comply with the requirements for Class B computing devices and labeled as set forth in 47 CFR 15.

1.2.2 Environmental Requirements

Equipment and cable to be utilized indoors shall be rated for continuous operation under ambient environmental conditions of 35 to 120 degrees F dry bulb and 10 to 95 percent relative humidity, noncondensing. Equipment shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location. Fiber optic cable for outdoor installation shall be rated for minus 20 to plus 120 degrees F.

1.2.3 Electrical Requirements

The equipment shall operate from a voltage source as shown, plus or minus 10 percent, and 60 Hz, plus or minus 2 percent.

1.2.4 Input Line Surge Protection

Inputs and outputs shall be protected against surges induced on wiring including wiring installed outdoors. Communications equipment shall be protected against surges induced on any communications circuit. Cables and conductors (except fiber optics which serve as communications circuits from consoles to field equipment) and between field equipment, shall have surge protection circuits installed at each end. Protection shall be furnished at equipment, and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within 3 feet of the building cable entrance. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

- a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
- b. An 8 microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.2.5 Power Line Surge Protection

Equipment connected to ac circuits shall be protected from power line surges. Equipment shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

1.3 DELIVERY OF TECHNICAL DATA

Computer software and technical data (including technical data which

relates to computer software), which are specifically identified in this specification shall be delivered strictly in accordance with the CONTRACT CLAUSES, SPECIAL CONTRACT REQUIREMENTS, and in accordance with the Contract Data Requirements List (CDRL), DD Form 1423, which is attached to and thereby made a part of this contract. All data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. The DTM system is being installed in conjunction with another system such as a closed circuit television system, and a utility monitoring and control system. The Technical Data Packages shall be submitted as part of the Technical Data Package for Section I.

1.3.1 Group I Technical Data Package

1.3.1.1 System Drawings

The package shall include the following:

- a. Communications system block diagram.
- b. FO receivers, transmitters, transceivers, and FO modem installation, block diagrams, and wiring diagrams.
- c. FO receivers, transmitters, transceivers, and FO modem physical layout and schematics.
- d. Details of interfaces with other systems.
- e. Details of connections to power sources, including grounding.
- f. Details of surge protection device installations.
- g. Details of cable splicing and connector installations.
- h. Details of aerial cable and messenger installation on poles, cable entrance to buildings, and termination inside enclosures.
- i. Details of underground cable installation, cable entrance into buildings, and terminations inside enclosures.

1.3.1.2 Equipment Data

A complete data package shall be delivered for all material, including field and system equipment.

1.3.1.3 Data Transmission System Description and Analyses

The data package shall include complete system description, and analyses and calculations used in sizing equipment required by these specifications. Descriptions and calculations shall show how the equipment will operate as a system to meet the specified performance. The data package shall include the following:

- a. FO receivers, transmitters, transceivers, FO modem transmit and receive levels, and losses in decibels (dB) on each communication link.
- b. Digital transmitter and receiver communication speed and protocol description.

- c. Analog signal transmission method and bandwidth of the transmitter and receiver.
- d. Data transmission system expansion capability and method of implementation.
- e. FO system signal-to-noise ratio calculation for each communication link.
- f. Flux-budget and gain margin calculation for each link.

1.3.1.4 System Overall Reliability Calculations

The data package shall include manufacturers' reliability data and calculations required to show compliance with the specified reliability. The calculations shall be based on the configuration specified in Section 13801 and as shown.

1.3.1.5 Certifications

Specified manufacturer's certifications shall be included with the data package.

1.3.2 Group II Technical Data Package

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall submit a report to the Government documenting changes to the site, or conditions that affect performance of the system to be installed. For those changes or conditions which affect system installation or performance, specification sheets shall be provided (with the report), or written functional requirements to support the findings, and a cost estimate to correct the deficiency. The Contractor shall not correct any deficiency without written permission from the Government.

1.3.3 Group III Technical Data Package

The Contractor shall prepare test procedures and reports for the factory test. A test plan and test procedures shall be prepared in accordance with Section 13801 and this specification. The test procedures shall describe the applicable tests to be performed, and other pertinent information such as specialized test equipment required, length of test, and location of the test. The procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements of this specification, and the methods for simulating the necessary conditions of operation to demonstrate performance of the system. The test report shall describe the results of testing to include the date, time, location and system component designations of material and equipment tested. Testing action shall be recorded whether successful or not. Reasons for termination of testing shall be described. Testing work sheets, printouts, strip charts, oscilloscope or OTDR photographs, raw and analyzed data and testing conclusions shall be included in the report. The Contractor shall deliver the test procedures to the Government for approval. After receipt by the Contractor of written approval of the test procedures, the Contractor may schedule the factory test. The Contractor shall provide written notice of the test to the Government at least 2 weeks prior to the scheduled start. The final test report shall be delivered within 15 days after completion of the test.

1.3.4 Group IV Technical Data Package

1.3.4.1 Performance Verification and Endurance Testing Data

The Contractor shall prepare procedures and reports for the performance verification test and endurance test. Test procedures shall be prepared in accordance with Section 13801 and this specification. Testing shall use the configured and installed system as approved by the Government. Where required, the Contractor shall simulate conditions of operation to demonstrate the performance of the system. The test plan shall describe the applicable tests to be performed, other pertinent information such as specialized test equipment required, length of performance verification test and endurance test, and location of the performance verification test and endurance test. The procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements of this specification, and the methods for simulating the necessary conditions of operation to demonstrate performance of the system.

The test report shall describe the results of testing to include the date, time, location and system component designations of material and equipment tested. Testing action shall be recorded whether successful or not. Reasons for termination of testing for any reason shall be recorded in the report. Testing work sheets, printouts, strip charts, oscilloscope or OTDR photographs, raw data, analyzed data and testing conclusions shall be included in the report. The Contractor shall deliver the performance verification test and endurance test procedures to the Government for approval. After receipt of written approval of test procedures, the Contractor may schedule the performance verification and endurance tests. The Contractor shall provide written notice of the performance verification test and the endurance test to the Government at least 2 weeks prior to the scheduled start of the test. The final performance verification test and endurance test report shall be delivered 30 days after completion of testing.

1.3.4.2 Operation and Maintenance Data

A draft copy of the operation and maintenance data, in manual format, as specified for the Group V technical data package, shall be delivered to the Government prior to beginning the performance verification test for use during site testing.

1.3.4.3 Training Data

Lesson plans and training manuals, including type of training to be provided, with a list of reference material shall be delivered for approval by the Government prior to starting any training.

1.3.5 Group V Technical Data Package

The Group V package consists of the operation and maintenance data, in manual format. Final copies of the manuals bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representative for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each

appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. Manuals delivered shall include:

- a. Functional Design Manual: two copies.
- b. Hardware Manual: two copies.
- c. Operator's Manual: two copies.
- d. Maintenance Manuals: two copies.

1.3.5.1 Functional Design Manual

The functional design manual shall identify the operational requirements for the data transmission system and explain the theory of operation, design philosophy, and specific functions. A description of hardware functions, interfaces, and requirements shall be included for all system operating modes.

1.3.5.2 Hardware Manual

A manual describing equipment furnished, including:

- a. General description and specifications.
- b. Installation and checkout procedures.
- c. Equipment electrical schematics and layout drawings.
- d. Data transmission systems schematics.
- e. Alignment and calibration procedures.
- f. Manufacturer's repair parts list indicating sources of supply.
- g. Interface definition.

1.3.5.3 Operator's Manual

The operator's manual shall fully explain procedures and instructions for operation of the system.

1.3.5.4 Maintenance Manual

The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.

1.4 SPARE PARTS

The Contractor shall submit data lists of spare parts, tools, and test equipment for each different item of material and equipment specified, after approval of detail drawings not later than one month prior to the date of beneficial occupancy. The data shall include a list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.

PART 2 PRODUCTS

2.1 FO MODEMS

FO modems shall be selected to meet FO system requirements. The modems shall allow full duplex, asynchronous, point-to-point digital communication using an FO pair.

2.1.1 FO Modem Operating Wavelength

The operating wavelength shall be centered on 1330 nanometers.

2.1.2 FO Modem Inputs and Outputs

FO modems shall accept inputs and provide outputs compatible with EIA ANSI/EIA/TIA-232-F, EIA ANSI/TIA/EIA-485-A, 20 mA current loop or T1. Digital data rates through each link shall be 38.4 KBPS or greater.

2.2 FO TRANSMITTER AND RECEIVER MODULES

FO transmitter/receiver pairs shall have signal-to-noise power ratio of 40 dB or better after photo detection at the receiver. Transmitter power output and receiver sensitivity shall not drift more than plus or minus 2 dB over their operational life.

2.2.1 Analog FO Transmitter and Receiver Modules

FO transmitter/receiver pairs used to pass analog video signals shall accept inputs and provide outputs that comply with EIA 170 and shall have a bandwidth of 6 MHz or greater.

2.2.2 Digital FO Transmitter and Receiver Modules

FO transmitter/receiver pairs used to pass digital signals shall accept inputs and provide outputs compatible with EIA ANSI/EIA/TIA-232-F, EIA ANSI/TIA/EIA-485-A, 20 mA current loop or T1. Digital data rates through each link shall be 38.4 KBPS or greater. FO transmitter and receiver modules shall be housed in field equipment enclosures where possible. FO transmitter and receiver modules shall be compatible with each other, the FO cable, and connectors.

2.2.3 FO Transmitter Module

The FO transmitter shall accept electronic signals and shall modulate a light source. The light source shall be coupled into an FO cable. The operating wavelength shall be centered on 1330 nanometers.

2.2.4 FO Receiver Module

The FO receiver module shall receive light from the FO cable and shall convert this light into an electronic signal identical to the electronic signal applied to the FO transmitter module. The operating wavelength shall be the same as the transmitter.

2.3 FO DIGITAL REPEATERS

FO digital repeaters shall be used to extend the range of the FO data transmission system when necessary to meet the requirements of paragraph SYSTEM REQUIREMENTS. For Duplex circuits, the repeater shall consist of a

pair of FO receivers that are connected to a pair of FO transmitters. The FO receivers shall receive the optical signal and drive the transmitters. The transmitters shall regenerate the optical signal at the transmission rate specified. The FO repeater shall be mechanically and optically compatible with the remainder of the FO system.

2.4 FO ANALOG REPEATERS

FO analog repeaters shall be used to extend the range of the FO data transmission system when necessary to meet the requirements of the paragraph SYSTEM REQUIREMENTS. For duplex circuits, the repeater shall consist of a pair of FO receivers that are connected to a pair of FO transmitters. The FO receivers shall receive the optical signal and drive the transmitters. The transmitters shall regenerate the optical signal in compliance with EIA 170. The FO repeater shall be mechanically and optically compatible with the remainder of the FO system.

2.5 TRANSCEIVERS FOR VIDEO APPLICATIONS

FO Transceivers shall allow bi-directional signal transmission on a single fiber. The operating wavelength shall be centered on 850 nanometers in one direction and centered on 1330 nanometers in the other direction. Crosstalk attenuation between channels shall be 40 dB or greater. FO transceivers shall be selected to match or exceed the highest data rate of attached input devices. The FO transceiver shall be mechanically and optically compatible with the remainder of the FO system.

2.6 TRANSCEIVERS FOR LAN APPLICATIONS

Transceivers for FO LAN applications shall be active units, compatible with the LAN cards, modems and repeaters used in the system. Indicators provided shall be for power, collision detection, receive, transmit, and status. Power for transceivers shall be derived from the AUI port of LAN equipment or from a dedicated power supply. Transceiver loss characteristics shall be less than 1.0 db. Connectors shall be low loss and compatible with LAN equipment. Circuitry shall be included so when a device is disconnected, other devices on the LAN continue to operate without any disruption.

2.7 FO SWITCHES

FO switches shall be single pole, double throw. Switching speed shall be less than 15 milliseconds. Insertion loss shall be less than 1.5 dB. Crosstalk attenuation between FO outputs shall be 40 dB or greater. FO switches shall be latching or nonlatching as shown.

2.8 FIBER OPTIC DROP REPEATERS (FODR)

FODRs shall combine the features specified for Fiber Optical Digital Repeaters and Local Area Network (LAN) transceivers. FODRs shall regenerate the optical signal at the transmission rate specified. The FODRs shall be mechanically and optically compatible with the remainder of the Fiber Optic system. FODRs shall restore the optical signals amplitude, timing and waveform. The FODR shall provide an electrical interface to the transmission media. The electrical interface shall be identical to all other network interfaces as specified.

2.9 DATA TRANSMISSION CONVERTER

Data transmission converters shall be used to connect equipment using EIA ANSI/TIA/EIA-485-A data transmission when necessary and as shown. Converters shall operate full duplex and support two wire circuits at speeds up to 2 megabytes per second and have a built in 120 Ohm terminating resistor. Converters shall be mechanically, electrically, and optically compatible with the system.

2.10 ENCLOSURES

Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish.

2.10.1 Interior

Enclosures installed indoors shall meet the requirements of Type 12 or as shown.

2.10.2 Exterior

Enclosures installed outdoors shall meet the requirements of Type 4X metallic.

2.11 SYSTEM REQUIREMENTS

2.11.1 Signal Transmission Format Code

FO equipment shall use the same transmission code format from the beginning of a circuit to the end of that circuit. Different transmission code formats may be used for different circuits as required to interconnect supported equipment.

2.11.2 Flux Budget/Gain Margin

FO links shall have a minimum gain margin of 6 dB. The flux budget is the difference between the transmitter output power and the receiver input power required for signal discrimination when both are expressed in dBm. The flux budget shall be equal to the sum of losses (such as insertion losses, connector and splice losses, and transmission losses) plus the gain margin. When a repeater or other signal regenerating device is inserted to extend the length of an FO circuit, both the circuit between the transmitter and the repeater-receiver, and the circuit between the repeater-transmitter and the receiver are considered independent FO links for gain margin calculations.

2.11.3 Receiver Dynamic Range

The dynamic range of receivers shall be large enough to accommodate both the worst-case, minimum receiver flux density and the maximum possible, receiver flux density. The receiver dynamic range shall be at least 15 dB. Where required, optical attenuators shall be used to force the FO link power to fall within the receiver dynamic range.

2.12 OPTICAL FIBERS

2.12.1 General

Optical fibers shall be coated with a suitable material to preserve the intrinsic strength of the glass. The outside diameter of the glass-cladded fiber shall be nominally 125 microns, and shall be concentric with the fiber core. Optical fibers shall meet EIA ANSI/EIA/TIA-455-46A, and EIA ANSI/TIA/EIA-455-177A.

2.12.2 62.5 Micron Multimode Fibers

Conductors shall be multimode, graded index, solid glass waveguides with a nominal core diameter of 62.5 microns. The fiber shall have transmission windows centered at 850 and 1330 nanometer wavelengths. The numerical aperture for each fiber shall be a minimum of 0.275. The attenuation at 1330 nanometers shall be 1.5 dB/Km or less. The minimum bandwidth shall be 160 MHz-Km at 850 nanometers and 400 MHz-Km at 1300 nanometers. FO cable shall be certified to meet EIA ANSI/EIA/TIA-455-30B and EIA ANSI/EIA/TIA-455-58B.

2.13 CROSS-CONNECTS

2.13.1 Patch Panels

Patch panels shall be a complete system of components by a single manufacturer, and shall provide termination, splice storage, routing, radius limiting, cable fastening, storage, and cross-connection. Patch panel connectors and couplers shall be the same type and configuration as used elsewhere in the system. Panels shall be wall mounted.

2.13.2 Patch Cords

Patch cords shall be cable assemblies consisting of flexible optical fiber cable with connectors of the same type as used elsewhere in the system. Optical fiber shall be the same type as used elsewhere in the system. Patch cords shall be complete assemblies from manufacturer's standard products.

2.14 CABLE CONSTRUCTION

2.14.1 General

The cable shall contain a minimum of two fiber optic conductors for each full duplex circuit. The number of fibers in each cable shall be as shown.

Each fiber shall be protected by a protective tube. Cables shall have a jacketed strength member, and an exterior jacket. Cable and fiber protective covering shall be free from holes, splits, blisters, and other imperfections. The covering shall be flame retardant, moisture resistant, non-nutrient to fungus, ultraviolet light resistant as specified and nontoxic. Mechanical stress present in cable shall not be transmitted to the optical fibers. Strength members shall be non-metallic and shall be an integral part of the cable construction. The combined strength of all the strength members shall be sufficient to support the stress of installation and to protect the cable in service. The exterior cables shall have a minimum storage temperature range of minus 40 to plus 167 degrees F. Interior cables shall have a minimum storage temperature of plus 14 to plus 167 degrees F. All cables furnished shall meet the requirement of NFPA 70.

Fire resistant characteristics of cables shall conform to Article 770,

Sections 49, 50, and 51. A flooding compound shall be applied into the interior of the fiber tubes, into the interstitial spaces between the tubes, to the core covering, and between the core covering and jacket of all cable because all locations are susceptible to moisture. Flooded cables shall comply with EIA ANSI/EIA-455-81A-91 and EIA ANSI/EIA/TIA-455-82B. Cables shall be from the same manufacturer, of the same cable type, and of the same size. Each fiber and protective coverings shall be continuous with no factory splices. Fiber optic cable assemblies, including jacketing and fibers, shall be certified by the manufacturer to have a minimum life of 30 years. Plenum cable shall meet UL 910, and riser cable shall meet UL 1666. FO cable shall be certified to meet the following: EIA ANSI/TIA/EIA-455-13A, EIA ANSI/EIA/TIA-455-25C, EIA ANSI/TIA/EIA-455-41A, EIA ANSI/EIA/TIA-455-47B, EIA ANSI/EIA/TIA-455-59A, EIA ANSI/EIA/TIA-455-61A, EIA-455-88, EIA ANSI/EIA-455-91, EIA TIA/EIA-455-104A, and EIA ANSI/EIA-455-171.

2.14.2 Exterior Cable

2.14.2.1 Duct Cable

The optical fibers shall be surrounded by a tube buffer, shall be contained in a channel or otherwise loosely packaged to provide clearance between the fibers and inside of the container, and shall be extruded from a material having a coefficient of friction sufficiently low to allow the fiber free movement.

- a. The cable outer jacket shall be medium density polyethylene material with orange pigment added for ease of identification.
- b. Tensile strength: Cables shall withstand an installation tensile load of not less than 608 pounds and not less than 135 pounds continuous tensile load.
- c. Impact and Crush resistance: The cables shall withstand an impact of 1.7lbs/in as a minimum, and shall have a crush resistance of 317 pounds per square inch as a minimum.

2.14.3 Pigtail Cables

Cable used for connections to equipment shall be flexible fiber pigtail cables having the same physical and operational characteristics as the parent cable. The cable jacket shall be flame retardant PVC or FCP, which complies with NFPA 70 for OFNP applications. Maximum dB loss for pigtail cable shall be 3.5 dB/km at 850 nanometers, and 1.0 dB/km at 1330 nanometers.

2.15 FO CONNECTORS

FO connectors shall be the straight tip, bayonet style, field installable, self-aligning and centering. FO connectors shall match the fiber core and cladding diameters. The connector coupler shall be stainless steel and the alignment ferrule shall be ceramic. FO equipment and cable shall use the same type connectors. Connector insertion loss shall be nominally 0.3 dB and less than 0.7 dB.

2.16 MECHANICAL SPLICES

Mechanical splices shall be suitable for installation in the field. External power sources shall not be required to complete a splice. Splices

shall be self-aligning for optimum signal coupling. Mechanical splices shall not be used for exterior applications where they may be buried underground or laced to aerial messenger cables. Mechanical splices may be used for interior locations and within enclosures. Splice closures shall protect the spliced fibers from moisture and shall prevent physical damage.

The splice closure shall provide strain relief for the cable and the fibers at the splice points.

2.17 CONDUIT, FITTINGS AND ENCLOSURES

Conduit shall be as specified in Section 16415A ELECTRICAL WORK, INTERIOR, and as shown.

PART 3 EXECUTION

3.1 INSTALLATION

System components and appurtenances shall be installed in accordance with the manufacturer's instructions and as shown. Interconnections, services, and adjustments required for a complete and operable data transmission system shall be provided.

3.1.1 Interior Work

Conduits, tubing and cable trays for interior FO cable interior shall be installed as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown. Cable installation and applications shall meet the requirements of NFPA 70, Article 770, Sections 52 and 53.

3.1.2 Exterior Underground Cable

Except as otherwise specified, conduits, ducts, and manholes for underground FO cable systems shall be installed as shown.

- a. For cables installed in ducts and conduit, a cable lubricant compatible with the cable sheathing material shall be used on all cables pulled. Pulling fixtures shall be attached to the cable strength members. If indirect attachments are used, the grip diameter and length shall be matched to the cable diameter and characteristics. If an indirect attachment is used on cables having only central strength members, the pulling forces shall be reduced to ensure that the fibers are not damaged from forces being transmitted to the strength member. During pulling the cable pull line tension shall be continuously monitored using dynamometers or load-cell instruments, and shall not exceed the maximum tension specified by the cable manufacturer. The mechanical stress placed upon the cable during installation shall be such that the cable is not twisted or stretched. A cable feeder guide shall be used between the cable reel and the face of the duct or conduit to protect the cable and guide it into the duct or conduit as it is unspooled from the reel. As the cable is unspooled from the reel, it shall be inspected for jacket defects or damage. The cable shall not be kinked or crushed and the minimum bend radius of the cable shall not be exceeded during installation. Cable shall be hand fed and guided through each manhole and additional lubricant shall be applied at all intermediate manholes. When practicable, the center pulling technique shall be used to lower pulling tension. That is, the

cable shall be pulled from the center point of the cable run towards the end termination points. The method may require the cable to be pulled in successive pulls. If the cable is pulled out of a junction box or manhole the cable shall be protected from dirt and moisture by laying the cable on a ground covering.

3.1.3 Service Loops

Each fiber optic cable shall have service loops of not less than 9.8 feet in length at each end. The service loops shall be housed in a service loop enclosure.

3.1.4 Splices

No splices will be permitted unless the length of cable being installed exceeds the maximum standard cable length available from a manufacturer or unless fiber optic pigtailed are used to connect transmitters, receivers, or other system components for terminations to the fiber. Splices shall be made using the method recommended by the cable manufacturer. Splices shall be housed in a splice enclosure and shall be encapsulated with an epoxy, ultraviolet light cured splice encapsulant or otherwise protected against infiltration of moisture or contaminants. FO splices shall be field tested at the time of splicing. Fusion splices shall have less than 0.2 dB loss.

Mechanical splices shall have less than 0.5 dB loss. There shall be no more than 1 splice per 0.62 mile in any of the FO cables excluding terminations. Field splices shall be located in cable boxes. Sufficient cable shall be provided in each splicing location to properly rack and splice the cables, and to provide extra cable for additional splices. Cable ends shall be protected with end caps except during actual splicing. During the splicing operations, means shall be provided to protect the unspliced portions of the cable and its fibers from the intrusion of moisture and other foreign matter.

3.1.5 Connectors

Connectors shall be as specified in paragraph FO CONNECTORS. Fibers at each end of the cable shall have jumpers or pigtailed installed of not less than 3 feet in length. Fibers at both ends of the cable shall have connectors installed on the jumpers. The mated pair loss, without rotational optimization, shall not exceed 1.5 dB. The pull strength between the connector and the attached fiber shall not be less than 50 pounds.

3.1.6 Identification and Labeling

Identification tags or labels shall be provided for each cable. Markers, tags and labels shall use indelible ink or etching which will not fade in sunlight, or in buried or underground applications. Markers, tags, and labels shall not become brittle or deteriorate for a period of 20 years. Label all termination blocks and panels with cable number or pair identifier for cables in accordance with EIA ANSI/TIA/EIA-606A and as specified. The labeling format shall be identified and a complete record shall be provided to the Government with the final documentation. Each cable shall be identified with type of signal being carried and termination points.

3.1.7 Enclosure Sizing and Cable

Termination enclosures shall be sized to accommodate the FO equipment to be installed. Sizing shall include sufficient space for service loops to be provided and to accommodate a neat, workmanlike layout of equipment and the bend radii of fibers and cables terminated inside the enclosure.

3.1.8 Enclosure Penetrations

Enclosure penetrations shall be from the bottom and shall be sealed with rubber silicone sealant to preclude the entry of water. Conduits rising from underground shall be internally sealed.

3.1.9 Conduit-Enclosure Connections

Conduit-enclosure connections shall be protected by tack welding or brazing the conduit to the enclosure. Tack welding or brazing shall be done in addition to standard conduit-enclosure connection methods as described in NFPA 70. Any damage to the enclosure or its cover's surface protection shall be cleaned and repaired using the same type of surface protection as the original enclosure.

3.2 TESTING

3.2.1 General

The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform testing.

3.2.2 Contractor's Field Test

The Contractor shall verify the complete operation of the data transmission system in conjunction with field testing associated with systems supported by the fiber optic data transmission system as specified in Section 13801 prior to formal acceptance testing. Field tests shall include a flux density test. These tests shall be performed on each link and repeated from the opposite end of each link.

3.2.2.1 Optical Time Domain Reflectometer Tests

Optical time domain reflectometer tests shall be performed using the FO test procedures of EIA ANSI/EIA/TIA-455-59A. An optical time domain reflectometer test shall be performed on all fibers of the FO cable on the reel prior to installation. The optical time domain reflectometer shall be calibrated to show anomalies of 0.2 dB as a minimum. Photographs of the traces shall be furnished to the Government. An optical time domain reflectometer test shall be performed on all fibers of the FO cable after it is installed. The optical time domain reflectometer shall be calibrated to show anomalies of 0.2 dB as a minimum. If the optical time domain reflectometer test results show anomalies greater than 1 dB, the FO cable segment is unacceptable to the Government. The unsatisfactory segments of cable shall be replaced with a new segment of cable. The new segment of cable shall then be tested to demonstrate acceptability. Photographs of the traces shall be furnished to the Government for each link.

3.2.2.2 Power Attenuation Test

Power attenuation test shall be performed at the light wavelength of the transmitter to be used on the circuit being tested. The flux shall be

measured at the FO receiver end and shall be compared to the flux injected at the transmitter end. There shall be a jumper added at each end of the circuit under test so that end connector loss shall be validated. Rotational optimization of the connectors will not be permitted. If the circuit loss exceeds the calculated circuit loss by more than 2 dB, the circuit is unsatisfactory and shall be examined to determine the problem. The Government shall be notified of the problem and what procedures the Contractor proposes to eliminate the problem. The Contractor shall prepare and submit a report documenting the results of the test.

3.2.2.3 Gain Margin Test

The Contractor shall test and verify that each circuit has a gain margin which exceeds the circuit loss by at least 6 dB.

3.2.2.4 Analog Video

Test Analog circuits shall be tested using a signal conforming to EIA 170. The monitor or automated test set shall be stable, and shall be as described in EIA 170. If the result is unsatisfactory, the circuit shall be examined to determine the problem. The Government shall be notified of the problem and of the procedures the Contractor proposes to eliminate the problem. The Contractor shall prepare and submit a report documenting the results of the test.

3.2.2.5 Performance Verification Test and Endurance Test

The FO data transmission system shall be tested as a part of the completed UMCS during the Performance Verification Test and Endurance Test as specified in Section 13801.

3.3 TRAINING

3.3.1 General

The Contractor shall conduct a training course for designated personnel in the maintenance of the FO system. The training shall be oriented to the specific system being installed under this specification. The Contractor shall furnish training materials and supplies.

3.3.2 Maintenance Personnel Training

The system maintenance course shall be taught at the project site after completion of the endurance test for a period of 1 training day. A maximum of five personnel designated by the Government will attend the course. A training day shall be 8 hours of classroom or lab instruction, including two 15 minute breaks and excluding lunchtime during the daytime shift in effect at the facility. Training shall include:

- a. Physical layout of the system and each piece of hardware.
- b. Troubleshooting and diagnostics procedures.
- c. Repair instructions.
- d. Preventative maintenance procedures and schedules.
- e. Calibration procedures. Upon completion of this course, the students shall be fully proficient in the maintenance of the

system.

-- End of Section --

SECTION 16792

WIRE LINE DATA TRANSMISSION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL TELECOMMUNICATION UNION (ITU)

ITU Blue Book (2000) Telecommunication Policies for the Americas (Data Communication Over the Telephone Network, Series V Recommendations (CCITT Blue Book - Vol VIII - Fascicle VIII.1))

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-80-576 (2000) Category 1 and 2 Individually Unshielded Twisted Pair Indoor Cables for Use in Communications Wiring Systems

ICEA S-84-608 (2002) Telecommunications Cable, Filled Polyolefin Insulated Copper Conductor

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

1.2 SYSTEM DESCRIPTION

1.2.1 General

A full duplex wire line data transmission system (DTS) for communication between a local device and a central processor shall be provided. The local device is used to process locally generated information and communicates that information to the central processor. The central processor is a computer-based system that takes the information received

from the local processor and processes that information. The DTS shall consist of MODEMS (headend and remote) and line drivers, or both, connected to the local device and the central processor. The MODEMS are connected by transmission lines and terminal devices such as connectors and terminal strips. Communication links surge protection and powerline surge protection shall be provided at both ends of the transmission line. All computing devices, as defined in 47 CFR 15, shall be certified to comply with the requirements for Class B computing devices and labeled as set forth in 47 CFR 15.

1.2.2 Environmental Requirements

Equipment and cable to be used indoors shall be rated for continuous operation under ambient environmental conditions of 35 to 120 degrees F dry bulb and 10 to 95 percent relative humidity, noncondensing. Equipment and cable to be used outdoors shall be rated for continuous operation under ambient environmental conditions of minus 40 to plus 176 degrees F and humidity of up to 100 percent condensing or as normally encountered for the installed location. All equipment shall be rated for continuous operation under the ambient vibration conditions encountered for the installed location. Components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust or ignitable fibers or flyings, shall be rated and installed in accordance with Chapter 5 of NFPA 70 and as shown.

1.2.3 Electrical Requirements

The equipment shall operate from a voltage source as shown, plus or minus 10 percent.

1.2.4 Power Line Surge Protection

All equipment connected to ac circuits shall be protected from power line surges. Equipment shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used for surge protection.

1.2.5 Communications Circuit Surge Protection

All communications equipment shall be protected against surges induced on any communications circuit. All cables and conductors which serve as communications circuit between the local processor and the central processor shall have surge protection devices installed at each end. Protection shall be provided at the equipment and additional triple electrode gas surge protectors rated for the application on each wireline circuit shall be installed within 3 feet of the building cable entrance. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

- a. A waveform with a 10 microsecond rise time, a 1000 microsecond width, a peak voltage of 1500 volts and a peak current of 60 amperes.
- b. A waveform with an 8 microsecond rise time, a 20 microsecond waveform, a peak voltage of 1000 volts and a peak current of 500 amperes.

1.3 DELIVERY OF TECHNICAL DATA

All items of technical data which are specifically identified in this specification will be delivered strictly in accordance with the CONTRACT CLAUSES, SPECIAL CONTRACT REQUIREMENTS, Section 01330 SUBMITTAL PROCEDURES and the Contract Data Requirements List, DD Form 1423, which is attached to and made a part of this contract. Technical data submitted shall be coordinated with the requirements of Section 13801. All data delivered shall be identified by reference to the particular specification paragraph against which it is furnished.

1.3.1 Group I Technical Data Package

1.3.1.1 System Drawings

The data package shall include the following:

- a. Data Transmission system block diagram.
- b. MODEMS and line drivers or both, installation, block diagrams, and wiring diagrams.
- c. MODEMS and line drivers or both, physical layout and schematics.
- d. Details of connections to power sources, including grounding.
- e. Details of interconnection with served system components.
- f. Details of surge protection device installation.
- g. Details of cable splicing and connector installation.
- h. Details of underground, aerial, and messenger cable installation on poles, cable entrance to building.

1.3.1.2 Manufacturers' Data

The data package shall include manufacturers' data for all materials including field and system equipment provided under this specification.

1.3.1.3 DTS Description and Analyses

The data package shall include complete system descriptions, analyses, and calculations used in selecting equipment required by these specifications. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance of this specification. The data package shall include the following:

- a. MODEM or line driver receive and transmit levels, signal-to-noise ratio calculations and assumed losses in decibels (dB) on each communication circuit.
- b. Communication speed and protocol description.
- c. Data transmission system expansion capability and method of implementation.

1.3.1.4 Certifications

All specified manufacturer's certifications shall be included with the data package.

1.3.2 Site Conditions

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall submit a report to the Government documenting changes to the site, or conditions that affect performance of the system to be installed. For those changes or conditions which affect system installation or performance, provide (with the report) specification sheets, or written functional requirements to support the findings, and a cost estimate to correct the situation. The Contractor shall not perform any corrections without written permission from the Government.

1.3.3 Operation and Maintenance Data

A draft copy of the operation and maintenance data, shall be delivered to the Government prior to beginning the performance verification test for use during site testing.

1.3.4 Training Data

Lesson plans and training data in manual format for the training phases, including type of training to be provided, with a list of reference material, shall be delivered for approval.

1.3.5 Manuals

Final copies of the manuals bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the testing. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representative for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. Manuals delivered may be in a single binder with items from Section 13801 and shall include:

- a. Functional Design Manual: two copies.
- b. Hardware Manual: two copies.
- c. Operator's Manual: two copies.
- d. Maintenance Manual: two copies.

1.3.5.1 Functional Design Manual

The functional design manual shall identify the operational requirements for the data transmission system and explain the theory of operation, design philosophy, and specific functions. A description of hardware functions, interfaces, and requirements shall be included for all system operating modes.

1.3.5.2 Hardware Manual

A manual describing all equipment furnished, including:

- a. General description and specifications.
- b. Installation and checkout procedures.
- c. Equipment electrical schematics and layout drawings.
- d. Data transmission system schematics.
- e. Alignment and calibration procedures.
- f. Manufacturer's repair parts list indicating sources of supply.
- g. Interface definition.

1.3.5.3 Operator's Manual

The operator's manual shall fully explain all procedures and instructions for operation of the system.

PART 2 PRODUCTS

2.1 COMMUNICATIONS EQUIPMENT

Communications equipment for circuits between sensors and field processors, and between the field processors and central processor, shall be capable of transmitting data within the error rate specified over the distances shown.

2.1.1 Modems

Modems shall conform to ITU Blue Book for a data rate of at least 9600 bits per second (bps), but must be compatible with all functional aspects of the entire UMCS system (Section 13801).

2.1.2 Line Drivers

Line drivers shall transmit data at a minimum of 9600 bps over the distances as shown, but must be compatible with all functional aspects of the entire UMCS system (Section 13801).

2.2 WIRELINE CABLE

Where not fiber optic, wireline cable shall be insulated solid copper type conforming to the following specifications. A minimum of No. 22 AWG shall be used for all applications.

2.2.1 Cable Construction

All cable components shall be able to withstand the environment the cable is installed in for a minimum of 20 years.

2.2.2 Underground Cable

ICEA S-84-608.

2.2.3 Aerial Cable

Not used.

2.2.4 Direct Burial Cable

Not used.

2.2.5 Interior Cable

Current issue of the NFPA 70 or ICEA S-80-576.

2.3 RACEWAY SYSTEMS

Raceway systems as specified in Section 16415 ELECTRICAL WORK, INTERIOR as shown shall be furnished. Utilize existing underground ductbank as shown.

2.4 ENCLOSURES

Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. The Contractor shall provide metallic enclosures to house the wireline DTS equipment. The enclosures shall be as specified or shown.

2.4.1 Interior

Unless indicated otherwise, enclosures to house wireline DTS equipment in an interior environment shall meet the requirements of NEMA 250, Type 12.

2.4.2 Exterior

Unless indicated otherwise, enclosures to house wireline DTS equipment in an outdoor environment shall meet the requirements of NEMA 250, Type 4.

2.4.3 Corrosion Resistant

Enclosures to house wireline DTS equipment in a corrosive environment shall meet the requirements of NEMA 250, Type 4X.

2.5 TAMPER PROVISIONS

2.5.1 Locks and Key-Lock Switches

2.5.1.1 Locks

All locks required to be installed on system enclosures for maintenance purposes shall be UL listed, conventional key type lock having a combination of five cylinder pin and five-point three position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." The locks shall be so arranged that the key can only be withdrawn when in the locked position. All maintenance locks shall be keyed alike and only two keys shall be furnished for all of these locks.

2.5.1.2 Key-Lock-Operated Switches

All key-lock-operated switches required to be installed on system components shall be UL listed, round-key type, with three dual, one

mushroom, and three plain pin tumblers or conventional key type lock having a combination of five cylinder pin and five-point three position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." Key-lock-operated switches shall be two position, with the key removable in either position. All key-lock-operated switches shall be keyed differently and only two keys shall be furnished for each key-lock-operated-switch.

PART 3 EXECUTION

3.1 INSTALLATION

System components and appurtenances shall be installed in accordance with the manufacturer's instructions and as shown. All necessary interconnections, services, and adjustments required for a complete and operable data transmission system shall be provided. Loading coils shall not be installed on cables provided for use with line drivers.

3.1.1 Enclosure Penetrations

Enclosure penetrations shall be from the bottom unless the system design specifically requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

3.1.2 Interior Electrical Work

Interior electrical work shall be installed as specified in Section 16415A ELECTRICAL WORK, INTERIOR and as shown.

3.1.3 Exterior Electrical Work

3.1.3.1 Underground

Except as otherwise specified, underground electrical and communications work shall be installed as shown.

- a. For cable installed in duct and conduit, a cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it into the duct and conduit as it is played off the reel. As the cable is played off the reel, it shall be carefully inspected for jacket defects. Precautions shall be taken during installation to prevent the cable from being "kinked" or "crushed." A pulling eye shall be attached to the cable and used to pull the cable through the duct and conduit system. Cable shall be hand fed and guided through each manhole. As the cable is played off the reel into the cable feeder guide, it shall be sufficiently lubricated with a type of lubricant recommended by the cable manufacturer. Where the cable is pulled through a manhole, additional lubricant shall be applied at all intermediate manholes. Dynamometers or load-cell instruments shall be used to ensure that the pulling line tension does not exceed the installation tension value specified by the cable manufacturer. The mechanical stress placed upon a cable during installation shall be such that the cable is not twisted or stretched.

3.2 TESTING

The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.

3.2.1 Wire Line Test

The Contractor shall test each wire line pair. The Contractor shall prepare reports containing test results and shall certify in the reports conformance to the following requirements.

3.2.1.1 Attenuation

Measurements shall be made with test tone of 1004 Hz at 0 dBm. Attenuation distortion not to exceed minus 3 dB to plus 12 dB from 300 to 3,000 Hz, and minus 2 dB to plus 8 dB from 500 to 2,500 Hz referenced to the attenuation of the 1004 Hz test tone. Attenuation at 1004 Hz of less than 40 dB.

3.2.1.2 Envelope Delay

Envelope delay distortion no greater than 1,750 microseconds over a range of 800 to 2,600 Hz.

3.2.1.3 Insulation Resistance

Insulation resistance wire to wire of wireline pair of at least 10,000 megohm-miles measured at 72 degrees F.

3.2.1.4 Loop Resistance

Loop resistance of less than 1,500 ohms.

3.2.2 Contractor's Field Test

The Contractor shall verify complete operation of the DTS during Contractor's Field Testing as specified in Section 13801. Field test shall include a bit error rate test. The Contractor shall perform the test by sending a minimum of 100,000 bits of data on each communication link and measuring errors. The bit error rate shall be not greater than 1 out of 100,000 for each link. The Contractor shall prepare a report containing results of the field test.

-- End of Section --

-- End of Specifications --